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HOMOLOGIES IN THE WING-VEINS OF MAY-FLIES.

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The following paper is an attempt to homologize the wing-veins of May-flies by a study of the tracheæ which precede them in the nymphal wing-pad.

The venation of May-flies has been many times discussed but only one work, that of the well known "Wings of Insects" by Comstock and Needham, has approached it from the standpoint of tracheation. This work suggested the present study.

At the outset I wish to express my indebtedness to Professor J. H. Comstock and Professor J. G. Needham for their many valuable criticisms. The work was done under the supervision of Professor A. D. MacGillivray, and while he disagrees with some of the interpretations herewith presented his constant interest and advice have made this study possible.

*Material and Methods.*

The genera with which this study deals are Epeorus, Iron, Ameletus, Ephemerella, Blasturus, Hexagenia, Polymitarcys, Ephemerella, Siphonurus, Callibaetis, Chironomus, Heptagenia, Leptophlebia, Choroterpes, and Cenis. Nymphs belonging to these fifteen genera were collected through the months from April to July inclusive, in the streams about Ithaca. They present as wide a range of variation as it was possible to obtain. The nymphs selected were those nearly matured whose wing-pads bore traces of venation easily seen with a hand lens. These were supplemented by younger nymphs showing tracheation only. Recently molted nymphs were used, since the wings of these lie flat upon the slide and both tracheation and venation show with great clearness. The method of preparation was that of the simple glycerine jelly mount. Nymphs were kept at hand in a dish of water. The wing-pad of one of the nymphs

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was quickly severed with a razor together with a portion of the thorax, in order to preserve the connection between the wing and body trachea. The wing was then placed upon a moistened slide and a cover glass bearing a little melted glycerine jelly was laid over it. The preparation was immediately cooled upon a slab of iron. It was examined as soon as the glycerine jelly hardened, and a camera lucida sketch or photograph was made. All of the figures here presented were secured by the latter method. From five to ten preparations of each form were photographed. Blue prints were made from the negatives. The outlines of the tracheæ and veins were then traced directly upon the print. Later the blue color of the paper was bleached out with a saturated solution of potassium oxalate. The ink drawing left upon the white field was then used directly for reproduction.

#### *Historical.*

The most important discussions of May-fly wing venation are contained in the following works.

EATON '83 (Revis. Monog. Ephem. '83) divided the veins of the May-fly wing into three groups to which he applied a series of names and numbers as given in the following table. The first group consisted of the longitudinal veins 1 (costa), 2 (subcosta), and 3 (radius), which are all connected by the great cross vein. The second group consisted of veins 4 (sector), 5 (cubitus), 6 (praebrachial) and 7 (pobrachial). The third group consisted of the anal and axillary veins. He called attention to the tendency of the hinder groups to secede from their own set and to annex themselves to the hinder branches of the group next in advance.

REDTENBACHER '86 used Eaton's system but altered it so that it would agree with the theory of convex and concave veins, proposed by Adolph, which Redtenbacher had unfortunately adopted. The May-fly wing was considered to be a very generalized type. Redtenbacher emphasized the relationship between May-flies and dragon-flies, stating that though transitional forms are lacking the wings of the two are so like as to be easily ascribed to a common origin.

COMSTOCK '88 adopted Eaton's system using the same grouping and homologies. He used names instead of numerals in labelling the veins.

COMSTOCK AND KELLOGG '95 built a system upon that of Redtenbacher, but they differed from him in certain particulars as to the homology of some of the veins. These differences are shown in a following table.

KELLOGG '95 reviewed the work of Redtenbacher and Comstock and proposed to further reduce the number of names. The result was a nomenclature which nearly approached that later adopted in the "Wings of Insects." Concerning the remnants of tracheation to be seen in an adult wing of *Hexagenia* he says: "In a mounted wing of *Hexagenia* sp. I have plainly observed the branching trachea of the sector arising from the radial trunk at an appreciable distance from the base of the radius." This seems incredible since an examination of many nymphs of this genus have failed to show this.

COMSTOCK AND NEEDHAM '98-'99. In this paper the tracheation of the nymphal wing-pads was discussed for the first time. The wing-veins of the adult were homologized from the tracheæ which preceded them. It was unfortunate that the authors studied only wing-pads in which the bases of the radial and medial tracheæ were approximated, and hence they also fell into the error of considering a part of media to be the radial sector.

For convenience in comparing the various systems of nomenclature I have arranged the following table:

Eaton '98 Rev. Monog. Ephem.	Redtenbacher '86	Comstock '96	Kellogg '96	Comstock- Needham '98	System used in this paper
Costa 1	Costa 1	Costa 1	Costa 1	Costa	Costa
Subcosta 2	Subcosta II	Subcosta II	(Subcosta) II	Subcosta	Subcosta
Radius 3	Radius III <sub>1</sub>	Radius III	(Radius) III (R+RS)	Radius	Radius
Radius 4	Radial sector III <sub>2</sub> Radial sector III <sub>3</sub> IV	Praemedial IV		Radial sector R <sub>2</sub> Access. radial 1	Media <sub>1</sub> Rs? Accessory 1
Cubitus 6	Cu VI			R <sub>4</sub> R <sub>5</sub>	N <sub>2</sub>
Praebrachial 6	Praebrachial VII	Media V	V	Media	M <sub>2</sub> and M <sub>4</sub>
Postbrachial 7	Postbrachial VIII	Postmedia VI	VII	Cubitus	Cubitus
Anal 8	Anal IX	Cub VII a b		1st Anal	1st Anal
Anal 9 <sub>1</sub>	Anal X	Anal	IX	2nd Anal	2nd Anal
Anal 9 <sub>2</sub>	Anal XI	Furrow VIII Anal Vein IX		3rd Anal	3rd Anal

The most generalized tracheation which has been found in May-flies is represented in young stages of the wing-pads of *Chironetes* (Pl. VII, Figs. 33, 34, 35). From these and other generalized wing-pads (especially Pl. V, Figs. 5, 7) the accompanying diagram has been drawn (Fig. 1). The trachea system of May-flies arises at one point in the longitudinal trachea of the thorax and enters the wing base by a single stem. Near that area which is to be the base of the adult wing the entering stem divides into two trunks. These two trunks remain undivided but a short distance.

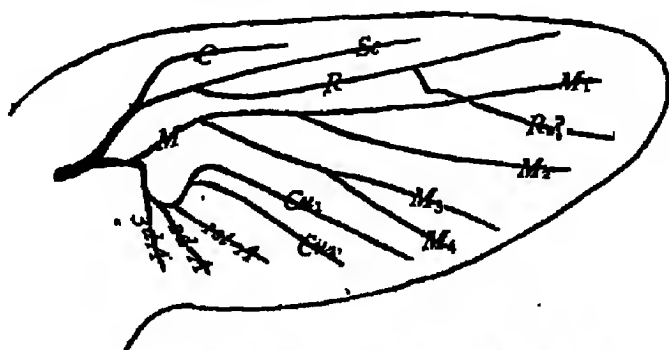


Fig. 1. Tracheation of hypothetical May-fly wing-pad.

The anterior trunk divides into two branches of unequal size. The smaller branch is a delicate trachea which extends forward, and outward parallel with the margin of the wing-pad. This is the costal trachea, (Fig. 1 C). The larger branch divides close to its base into two tracheae which extend nearly to the margin of the wing-pad. The anterior of these two tracheae is the sub-costal (Fig. 1, Sc) and the posterior one the radial trachea, (Fig. 1, R).

The foremost branch of the posterior trunk is the medial trachea, (Fig. 1, M). Beyond the point of its separation it divides into four branches. This agrees well with the condition of this vein in insects generally. The posterior branch bends toward the anal margin of the wing-pad. From its basal part three separate branches are given off. These are the 1st, the 2nd and the 3rd anal tracheae. (Fig. 1, 1st A, 2nd A, 3rd A). A little beyond the 1st anal branch the trachea splits into the two prominent cubital tracheae. (Fig. 1, Cu<sub>1</sub>, and Cu<sub>2</sub>).

*Peculiarities of May-fly tracheation.*

If the tracheation of May-flies (Fig. 1) be compared with the most generalized types of tracheation in other orders several striking peculiarities will be observed.

The radial trachea instead of showing its typical five parts is usually destitute of a sector (cf. Pl. V, Fig. 5 with Figs. 1, 3, etc.).

The medial trachea has its characteristic four parts (Pl. V, Fig. 1) but the  $M_1$  trachea bears a branch on the posterior side (labelled  $R_1$  ? in the figures) in which it appears to terminate.

If the tracheation in the consecutive figures of the wing-pads in Pls. V, VI, VII, be now examined important differences will be seen. The series shows a continuous reduction of large tracheae and a replacement of them by small tracheal branches. A gradual evolution in the tracheation is thus suggested. An evolution by reduction, which has left some principle tracheae so reduced as to be hardly recognizable but still holding their proper places.

*The Costal and Sub-costal Tracheae.*

The usual course of the costal trachea has been already described. Whenever present in well developed wing-pads it lies without exception in the developing vein which forms the front margin of the wing-pad and which is universally considered to be vein C.

This trachea has been found present as a short, delicate branch in the wing-pads of all but four genera, (Hexagenia, Polymitarcys, Ephemera, Ephemerella, Pl. V, Fig. 13, Pl. VI, Figs. 19, 21, 27). In one, (Ephemerella) this absence may have been due to the rather poor material, but in the others, examinations of many specimens failed to show its presence. The wing-pads of Chironetes, Heptagenia, Epeorus, and Iron (Pl. V, Figs. 1, 3, 5, 7, 9,) show a continuous reduction of the costal trachea. In Chironetes (Fig. 1) its branches thoroughly aerate the base of the costal region. In the succeeding wing-pads its diminished branching makes the costal trachea less and less important in the aeration of this region. Its work is carried on by branches which spring from the trachea behind it.

The sub-costal trachea is a single usually strong trachea which is parallel to the margin of the wing-pad. It lies in the longitudinal vein posterior to vein C, (Pl. V, Fig. 1). In none

of the wing-pads examined has there been any indication of a splitting of the sub-costal trachea into its two branches  $Sc_1$  and  $Sc_2$ .

In the first eleven wing pads in Plates V, VI, (Figs. 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21) and in *Siphylurus* (Pl. VII, Fig. 29) the sub-costal trachea extends to the tips of the wing-pads. It not only aerates its own area, but in some wing-pads it supplies the region before (Pl. VI, Fig. 15), and in others the region before and behind it (Pl. VI, Fig. 17). The sub-costal trachea of *Choroterpes*, *Leptophlebia*, and *Blasturus* (Pl. VI, Figs. 23, 25, 27) has nearly disappeared from its vein and is replaced by branches from the trachea behind it. This condition is similar to that which has already been noted in the costal trachea. It is a further step in the cutting down of main tracheæ.

#### *Radial Trachea.*

The remaining branch of the anterior trunk is a simple trachea parallel to the sub-costal trachea. It never deviates from its pathway in the radial vein. This is the radial trachea. It has been found to be unbranched except in one species of *Heptagenia* (Pl. V, Fig. 5) and in only half of the specimens of this.

In all cases except in *Heptagenia* (Pl. V, Figs. 3, 5) it is distinct from the medial trachea throughout its course. In *Heptagenia* both divisions of the main trunk have coalesced at the base so that the radial and medial tracheæ appear to arise from the same stem (Pl. V, Fig. 3, 5).

The development of the radial trachea is variable and its length has important effects upon the aeration of the region behind it. In the more generalized wings (Pl. V, Figs. 1, 3, 5, 7, 9, 11) it extends to the apex of the wing-pad. Ample aeration of the wing-tip is thus provided. In the more specialized wing-pads the radial trachea extends only through the basal third (Pl. V, Fig. 13, Pl. VI, Figs. 15, 17, 19, 21, 27), or has almost disappeared (Pl. VI, Fig. 25).

A progressive development of fine tracheal branches follows the weakening of the radial trachea. When the trachea is reduced its area is aerated by fine branches from the tracheæ before and behind it (Pl. V, Fig. 13, Pl. VI, Figs. 15, 17, 25, 27, Pl. VII, Figs. 29, 31). Thus the place of a main trachea is again taken by secondary branches.

*Medial Trachea.*

The fullest development of tracheal branches is found in *Chironetes* (Fig. 2). The four typical branches of media are present and well developed and there is a large accessory trachea attached posteriorly to the  $M_1$  trachea and smaller ones attached posteriorly to  $M_2$ . These accessories are usually wanting and need no further consideration. There is however, one peculiarity of the tip of  $M_1$ , which is of great importance since it involves the interpretation of the veins in the area between veins  $M_1$  and  $M_2$ . Here lies the most difficult problem in the interpretation of May-fly venation.

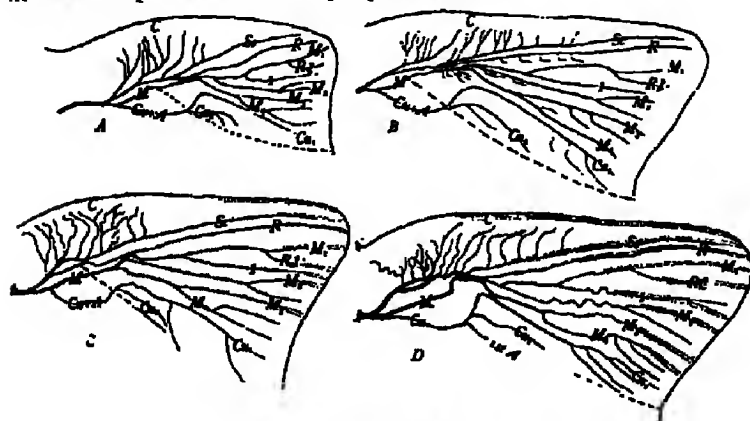


Fig. 2. Tracheation in nymphal wings of *Chironetes*.  
A, B, C—Three early stages.  
D—Late stage showing venation also.

Trachea  $M_1$  continues through only half its course (Fig. 2, D). An apparent continuation of it turns abruptly rearward and lies in the strong oblique vein  $Rs^2$ . This condition exists in mature wing-pads of *Chironetes* and in all the most generalized wing-pads, (Pl. V, Figs. 1, 3, 5, 7, 9, 11). In very young wing-pads of *Chironetes* however the  $M_1$  trachea extends through its whole course to the tip of vein  $M_1$ , (Fig. 2, A, B, C).

The  $M_2$  trachea lies in the corresponding vein. The  $M_2 + M_3$  trachea continues for some distance before dividing. It then separates into the two branches  $M_2$  and  $M_3$ , which diverge slightly and proceed to the margin in a parallel course.

In *Chironetes* small branches are almost completely absent from the medial tracheæ. In the series of wing-pads



which follow it the progress of the medial trachea from a generalized to a specialized condition is marked by a general development of small tracheoles which aerate this region. This has resulted from the reduction of the main tracheæ. Specialization is also marked by an increasing importance of the fore part of the medial trachea. In this the accessory trachea take no part, but disappears entirely. The reduction of the tip of the  $M_1$  trachea has taken place because that region is so well aerated by the radial trachea, (Pl. V, Figs. 1, 3, 5, 7, 9, 11). When the radial trachea is greatly reduced (Pl. V, Fig. 13, Pl. VI, Figs. 15, 17, 19, 21, 23, 25, 27) the vein  $M_1$  contains a trachea throughout, although in more generalized forms the terminal portion is wanting, or its area is supplied by tracheoles, (Pl. VII, Figs. 29, 31).

When the costal and sub-costal trachea are also reduced as they are in *Choroterpes*, *Leptophlebia*, *Blasturus*, and *Callibaëtis* (Pl. VI, Figs. 23, 25, 27, Pl. VII, Fig. 31) the whole front of the wing is dependent upon branches from the  $M_1$  trachea. With this increase in function the  $M_1$  trachea usually becomes proportionately larger (Pl. VI, Figs. 23, 25, 27) or it gives place to a mesh work of tracheoles (Pl. VII, Fig. 31).

The Accessory<sub>1</sub> (1) disappears early in this series. In *Chironectes* it extends to the margin; in *Heptagenia* (Pl. V, Fig. 3) it sends a branch over into the tip of vein  $M_2$ . In *Epeorus* (Pl. V, Fig. 7) it has become greatly shortened, and only its stump is left in *Iron* (Pl. V, Fig. 9). The vein which succeeds it is one of the most prominent accessories in the May-fly wing. In most of the wing-pads this vein is aerated by branches from the tracheæ before and behind it (Pl. V, Fig. 13, Pl. VI, Figs. 15, 17, 23).

The  $M_2$  trachea maintains its full length and gains importance as the tracheæ near it become reduced. In *Chironectes* there is no need for the short posterior branch which it bears, but in *Heptagenia* (Pl. V, Fig. 5) a branch in approximately the same position aerates vein  $M_2$  and an accessory. This function is similarly performed in *Choroterpes* and *Blasturus*, (Pl. VI, Figs. 25, 27) and by means of tracheoles in other wing-pads (Pl. VI, Figs. 15, 17).

If the course of the  $M_1+4$  trachea be followed through this series it will be seen that there is a continuous reduction of this trachea which ends in its complete obliteration. At first the

the trachea has accessory branches. (Pl. V, Figs. 1, 3). These are lost and the  $M_1$  and  $M_2$  trachea course toward the margin as simple parallel tracheæ (Pl. V, Fig. 7). Later the  $M_1$  trachea becomes reduced (Pl. V, Fig. 9) and ultimately disappears. In *Hexagenia* (Pl. V, Fig. 13) both the  $M_1$  and  $M_2$  tracheæ have disappeared and a secondary trachea has been developed which lies in the accessory vein between vein  $M_2$  and  $M_4$ . A variation of this occurs in *Ephemera* where the secondary trachea springs from the  $M_2$  trachea (Pl. VI, Fig. 17). In the wing-pads which follow, the  $M_2+4$  trachea has either nearly disappeared (*Leptophlebia* and *Siphilurus*, Pl. VI, Fig. 23, Pl. VII, Fig. 29), or it has become entirely obliterated (*Leptophlebia* and *Callibætis*, Figs. 23, 31). In the former cases it is visible in very clear preparations as a small but very distinct trachea lying in the base of vein  $M_2+4$ . The veins deserted by this trachea are thoroughly aerated by a network of small branches from the tracheæ before and behind. (Pl. VI, Figs. 23, 25; Pl. VII, Figs. 29, 31). Sometimes variable secondary tracheæ from either side (see *Blasturus* Pl. VI, Fig. 27, and *Blasturus* Pl. VII, Fig. 40, another specimen) aerate the region between vein  $M_2$  and  $M_4$ .

The climax of the changes in the aeration of the medial region is illustrated by the wing-pads of *Siphilurus* and *Callibætis*, (Pl. VII, Figs. 29, 31). In the former but two strong tracheæ remain, the  $M_1$  trachea with its apparent continuation and the  $M_2$  trachea. In *Callibætis* only the  $M_1$  trachea is still strong. All the other tracheæ in the wing-pad are weakened.

#### *The Radial Sector.*

In the preceding description no mention of a radial sector has been made, the radial trachea being described as an unbranched trachea and the vein R as an unbranched vein. It is strange that so important an element should be lacking in a wing where the venation is not greatly reduced.

Between  $M_1$  and  $M_2$  there is an undetermined vein which may be an accessory vein or may be the radial sector in an unusual position. This second possibility becomes a very strong probability when we consider what has happened in the Odonata. As has been conclusively shown (Comstock and Needham '98-'99) and (Needham '03) an actual switching of the sector trachea there takes place.

In the dragon-flies (Anisoptera) all stages of this switching are shown. In very young nymphs of dragon-flies the tracheae are all separate and in their usual position (Fig. 3A).

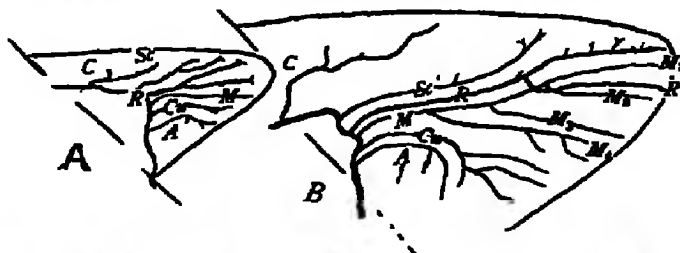


Fig. 3. Two stages of nymphal wings of dragon-fly *Gomphus desertus*, after Needham, showing change in position of sector trachea.

In the next stage the radial sector trachea has migrated across the  $M_1$  trachea and reaches the margin between the  $M_1$  and  $M_2$  tracheae (Fig. 3B). This modification is carried still further in the mature stage where the radial sector is between the  $M_2$  and  $M_3$  trachea. In the adult wing the place where the radial sector crosses over to  $M_1$  is always marked by an oblique cross vein.

In the damsel-flies (Zygoptera) the  $R_s$  trachea is always attached to  $M_1$ . There is no connection thus far found between the radial trachea and its sector which is completely stranded upon the  $M_1$  tracheae. In the adult wing an oblique cross vein marks the point of crossing over of the sector in only a very few genera.

In May-flies this trachea is one of the most constant features of the tracheation. The vein which follows it is likewise constant in the adult wing. In one species of this series an actual crossing of a strong branch of radius across the  $M_1$  trachea has been found (Fig. V, Pl. 5). A large number of the wing-pads of this species were examined. Half of the wing-pads showed the radial branching just described and half of them gave no sign of it (Pl. VII, Fig. 41). An actual connection between the  $R$  and the  $R_s$  trachea cannot be shown by constant structures. However, May-flies and dragon-flies are closely allied groups and their general tracheation is similar in many points. Furthermore this condition of the radial sector trachea is exactly the same as that just described in the damsel-flies where there can be no doubt that such a crossing has taken place. It is, therefore,

highly probable that the radial sector is present in May-flies and that both the sector trachea and the vein  $R_s$  have been branched on  $M_1$  and have left no positive trace of their origin.

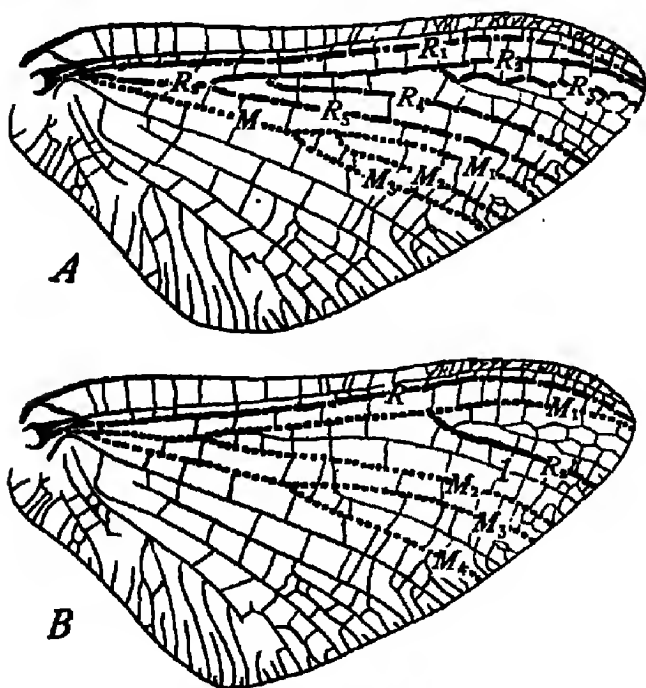


Fig. 4. WINGS OF EPHEMERA.

A. Previous interpretation of radius and media.

B. Present interpretation of radius and media.

Radius and its supposed sector are represented by dots and dashes, media is represented by a series of dots.

Such an interpretation involves important changes in the nomenclature of the veins in the radial and medial regions. These changes may be clearly seen by comparing the wings A and B in the accompanying figure (Fig. 4).

#### *The Cubital Trachea.*

In *Chironomus* (Pl. V, Fig. 1) the cubito-anal and medial tracheae diverge and then run nearly parallel for a short distance. In this region the anal tracheae branch off (Pl. V, Fig. 1, 1st A). The cubital trunk then bends forward again toward the medial trachea, making a prominent bend just below the first fork of

media. It soon splits into two branches which extend near to the anal margin. These branches are the  $Cu_1$  trachea and the  $Cu_2$  trachea. The  $Cu_1$  trachea lies constantly within the vein directly behind vein  $M_1$  and the  $Cu_2$  trachea within the next primary vein behind  $Cu_1$ .

A prominent bend in the cubital trunk is a characteristic feature of May-fly tracheation. Variations of it have been found in all but one (Pl. V, Fig. 5) of the wing-pads examined. (Pl. V, Figs. 7, 9, 11; Pl. VI, Figs. 15, 17; Pl. VII, Fig. 31). In the last case (*Callibaetis*) the cubito-anal stem has joined the general approximation of the tracheal trunks outward and the cubital bend is no longer evident.

The replacement of main tracheæ by small branches is not usual in the cubital region as it is in the radial and medial. It does occur however in *Blasturus* and *Siphururus* (Pl. VI, Fig. 27; Pl. VII, Figs. 29, 40) where small branches of the  $Cu_1$  trachea supply the  $M_1$  vein. With few exceptions (Pl. V, Figs. 1, 3, 7) the cubital trachea are entirely unbranched.

#### *The Anal Tracheæ.*

The anal stem is a well defined trachea which splits off from the cubito-anal trunk just before the cubital bend.

In the mature wing-pad of an *Ephemera* (Pl. VI, Fig. 17) the three anal tracheæ are present. In this wing-pad the 1st A trachea is a strong branch which separates from the distal part of the anal trunk and extends to the margin. It lies in the next primary vein posterior to vein  $Cu_2$ . From the posterior side of the 1st A trachea several secondary branches are given off. These are followed by secondary veins. The 2nd A trachea separates from the trunk directly behind the accessory tracheæ. The 3rd anal trachea is a short branch which arises posterior to these accessories. Both the 2nd A and 3rd A tracheæ are followed by primary veins (Pl. VI, Fig. 17). From the evidence presented in the nymphal wing-pads and the wings of the sub-imago we have considered veins 1st, 2nd, and 3rd A to be typical of May-flies.

In *Chironomus* (Pl. V, Fig. 1) I have been able to demonstrate but one anal trachea. In this and all the other genera examined the anal tracheæ appear much later than those lying farther anterior. This fact accounts for their absence in many of these figures. The first anal trachea has been found in all of

wing-pads examined and the second in three (Pl. V, Fig. 5; VI, Fig. 17, Pl. VII, 31). All of the anal tracheæ have been nearly always found in recently emerged sub-imagoes.

Replacement of main tracheæ by small branches does not occur in the anal region. As might be expected, the burden of aeration does not fall here but in the middle region of the wing-pad.

### *The Tracheal Stem.*

As already stated, the single tracheal stem of May-flies is similar to that of no other order, those of other insects as far as known having a dorsal and ventral root (Fig. 5, A. a, b).

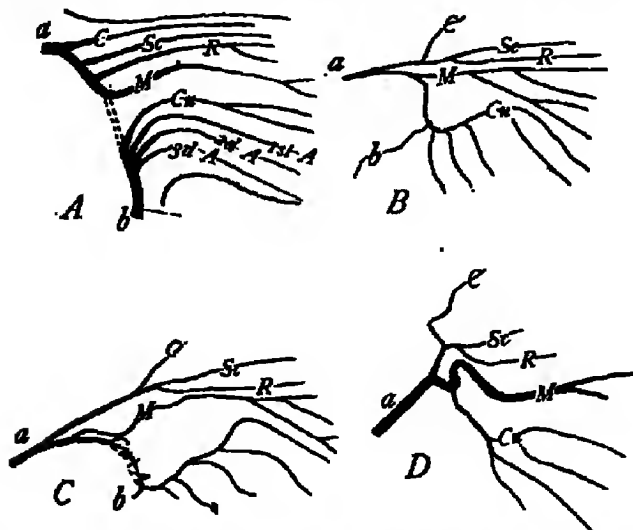


Fig. 5. Diagrams of Tracheal Stems showing shifting of the cubito-anal trachea.

- A. Tracheal bases in the hypothetical wing of insects (after Comstock and Needham).
- B. In the wing-pad of a hypothetical May-fly.
- C. In the generalized wing-pad of *Epeorus*.
- D. In the specialized wing-pad of *Callibaetis*.

In these wing-pads the base of the cubito-anal trachea makes a characteristic prominent downward loop (Fig. 5, B, C). This loop swings the trachea out of the route which it would seem naturally to take. It is more prominent in generalized than in specialized wing-pads (Fig. 5, of C and D).

In some generalized wing-pads a weak branch springs from the cubito-anal loop and extends inward toward the body, nearly parallel with the main stem. (b, in Fig. 5, C). These structures have prompted the suggestion that the weak trachea (b, in Fig. 5, C) may be the remnant of the trachea which connects the trachea of the wing with the ventral body trachea in other orders (b, in Fig. 5, A).

### *Fossil May-flies.*

On account of the difficulty in studying fossil wings only a very brief consideration has been given to them. A few figures of fossil wings believed to be those of May-flies have been copied. (Pl. IX, Figs. 62, 63, 64, 65, 66, 67). The homologies here determined have been applied to these wings. All but the last figure are taken from "Types of Permian Insects" by E. H. Sellards<sup>1</sup>. In these May-flies the fore and hind wings are nearly equal in size, as they are in damsel-flies. The parallel veins of the front part of the wing and the main branches of media are identical with those of modern May-flies. The last figure (*Bætis anomala*)<sup>2</sup> represents a recent fossil in which the hind wings show the reduction which is the present characteristic of May-flies.

### *Hind Wings.*

The hind-wings of May-flies are greatly reduced in size. In *Cænis* they are entirely lacking. In consequence of this reduction there are important differences in the front and hind wings. By reason of it also the venation is so reduced as to be of far less value in practical use.

The wing-pads of *Chironetes* show the most generalized tracheation of any which have been studied. In these the bases of the tracheal trunks are similar to those of the front wing (Pl. VIII, Fig. 43). The tracheae however show these differences. The  $M_1$  trachea always extends to the margin of the wing-pad. There is no trace of either the  $R_s$ ? or the 1st accessory trachea. These veins, however, are present and occupy positions identical with the corresponding veins of the front-wing

<sup>1</sup>E. H. Sellards. Types of Permian Insects. Amer. Jour. of Science, Vol. XXIII, May, 1907. pp. 345-355.

<sup>2</sup>G. C. Berendt. Die im Herstein befindlichen Organischen Reste der Vorwelt. 1856. Zweiter Band. Abt. II. Neuropteren (Pictet Baraban & Hagen). Tab. VI. Fig. 1.

In the wing-pads figured in Pl. VIII, there is a gradual reduction of the main trachea in the front of the wing. This is shown first in *Heptagenia* (Pl. VIII, Fig. 45) where the base of the subcostal trachea has apparently fused with the radial trachea, later by its total obliteration, (Pl. VIII, Fig. 51). In all of these except *Callibaetis* the Sc has been the only vein to disappear (Pl. VIII, Figs. 46, 48, 50, 54). Between  $M_1$  and  $M_2$  there are several accessory veins which are generally bent backward and attached to the vein next posterior. The direction of their bending is just the opposite of these same accessories in the fore-wing.

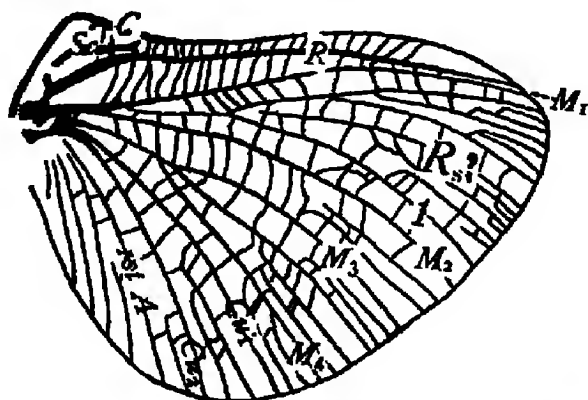


Fig. 6. Hind wing of *Palingenia longicauda* Oliv. (After Eaton.)

The direction and the attachment of these accessories was traced through a series of hind-wings. In a few of the generalized wings they were bent forward and attached to vein  $M_1$  (*Palingenia*, Fig. 6) like the similar accessories of the fore-wing. Between this anterior attachment to  $M_1$  and the posterior joining to  $M_2$ , figured in *Heptagenia* (Pl. VIII, Fig. 46) there were many intermediate positions. One of these is represented by *Chironetcs* (Pl. VIII, Fig. 44). We may conclude then that the wing of *Palingenia* represents a generalized type of the hind wing in which a number of accessory veins are joined to  $M_1$  and  $M_2$  is a simple vein. This condition is very near to that in the fore-wing. By a general shifting backward the accessory veins have been thrown upon vein  $M_2$  and have thus made it secondarily a branched vein. There are 3 sizes of



intercalaries as in front wing. The hindmost is longest as in front-wing, two others are of intermediate length. The Acc. and Rs? are in positions identical with the corresponding vein of the front wing. Sub-costa is much reduced; in most cases entirely wanting. In *Palingenia* (Fig. 6, Sc) it is a strong but very short vein.

#### *Summary.*

This is a study of the ontogeny of wings representing fifteen genera of May-flies in which the following facts are shown:

1. The main veins of May-flies may be homologized with the veins of insects of other orders.
2. The main tracheæ precede and constantly mark the course of the main veins.
3. The costal and subcostal tracheæ are simple and parallel as are the veins which follow them.
4. The radial trachea (except in one form studied) and the vein which follows it are unbranched.
5. The radial sector is very probably present in May-flies but in an unusual position between the veins  $M_1$  and  $M_2$ . It is detached from radius, as in the dragon-flies, and stranded upon vein  $M_1$ .
6. The medial trachea and the vein M show four branches which are characteristic of media in its primitive condition. It is similar to the media in the closely allied dragon-flies.
7. The tracheal system enters the wing by a single stem. The course of the cubito-anal trunk shows a possible trace of the double stem of the tracheal system of other orders.
8. In the series of wing-pads studied a remarkable evolution of tracheation is shown. This evolution consists of a gradual reduction of main tracheæ and replacement by small branches.
9. This interpretation of the venation involves the important changes of nomenclature shown in Fig. 4.

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## EXPLANATION OF PLATES.

## PLATE V.

(In the wing-pads continuous lines represent tracheæ and tracheolæ; dotted lines represent developing veins.)

- Fig. 1. Wing-pad of *Chironetes albomanicus*. Needham.
- " 2. Wing of "
- " 3. Wing-pad of *Heptagenia* sp.?
- " 4. Wing of "
- " 5. Wing-pad of *Heptagenia* sp. (nymph No. 3 Needham).
- " 6. Wing of "
- " 7. Wing-pad of *Epeorus humeralis* Morgan.
- " 8. Wing of "
- " 9. Wing-pad of *Iron fragilis* Morgan.
- " 10. Wing of "
- " 11. Wing-pad of *Ameletus ludens* Needham.
- " 12. Wing of "
- " 13. Wing-pad of *Hexagenia* sp.?
- " 14. Wing of "

## PLATE VI.

- Fig. 15. Wing-pad of *Polymita cyrcus* Say.
- " 16. Wing of "
- " 17. Wing-pad of *Ephemera* sp.
- " 18. Wing of "
- " 19. Wing-pad of *Cacis diminuta* Walker.
- " 20. Wing of "
- " 21. Wing-pad of *Ephemerella rotunda* Morgan.
- " 22. Wing of "
- " 23. Wing-pad of *Leptophlebia* sp?
- " 24. Wing of "
- " 25. Wing-pad of *Choroterpes* sp?
- " 26. Wing of "
- " 27. Wing-pad of *Blasturus cupidus* Say.
- " 28. Wing of "

## PLATE VII.

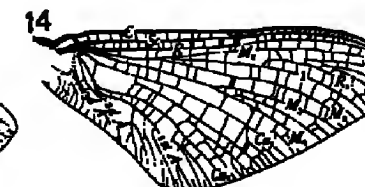
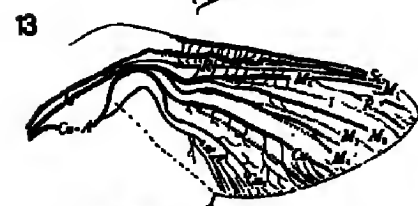
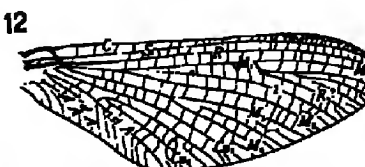
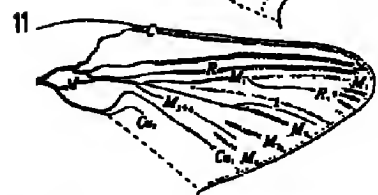
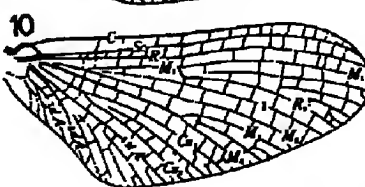
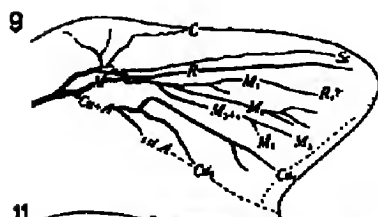
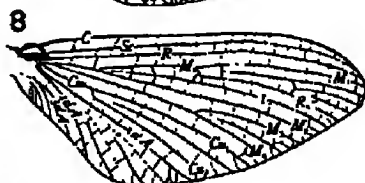
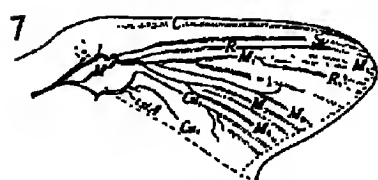
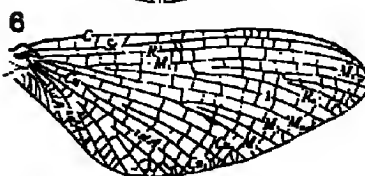
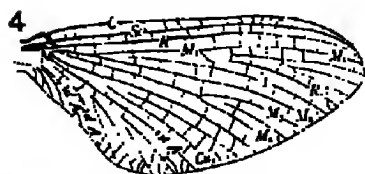
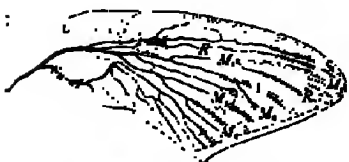
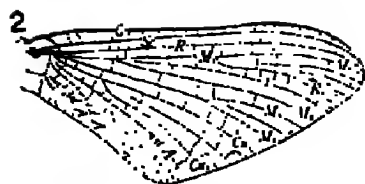
- Fig. 29. Wing-pad of *Siphurur* sp?  
 " 30. Wing of "  
 " 31. Wing-pad of *Callibaetis* sp?  
 " 32. Wing of "  
 " 33. "  
 " 34. } Successive stages of wing-pads of *Chironomus albomaculatus* Needh.  
 " 35. }  
 " 36. }  
 " 37. } Successive stages of wing-pads of *Blasturus cupidus* Say.  
 " 38. }  
 " 39. Base of wing-pad of *Hexagenia* sp?  
 " 40. Wing-pad of *Blasturus cupidus* showing variation in aeration.  
 " 41. Wing-pad of *Heptagenia* sp? (No. 3 Needham). showing variation in "  
 " 42. Wing-pad of *Ephemera* showing slight variation in tracheation.

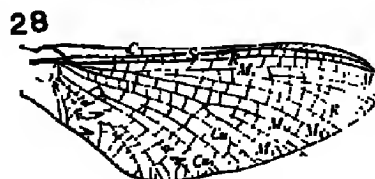
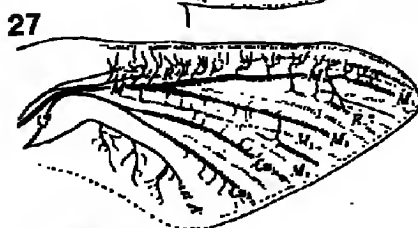
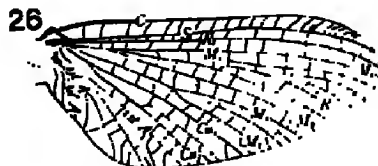
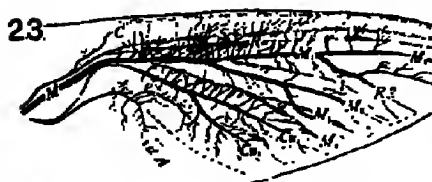
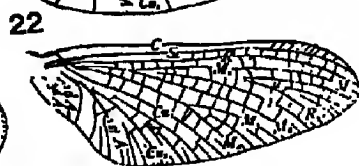
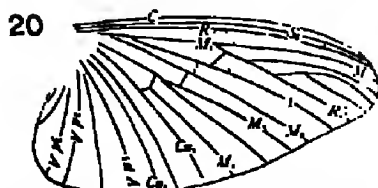
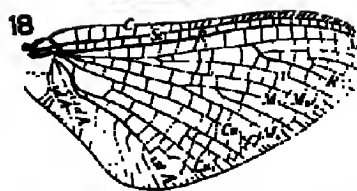
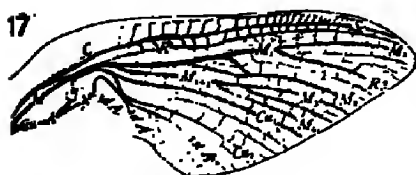
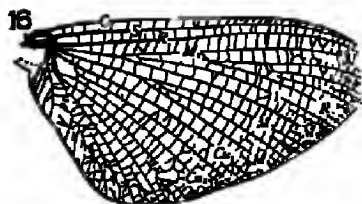
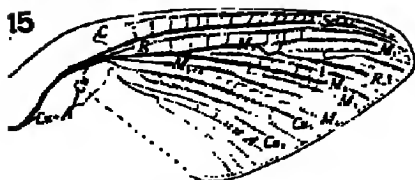
## PLATE VIII.

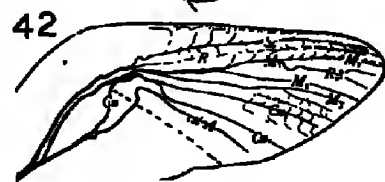
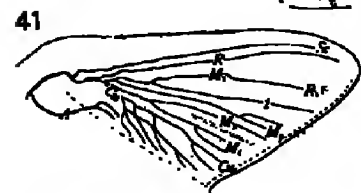
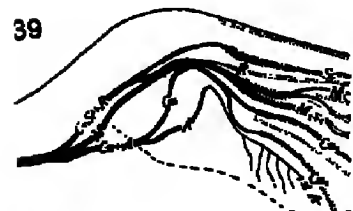
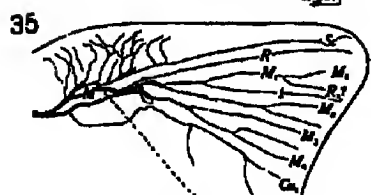
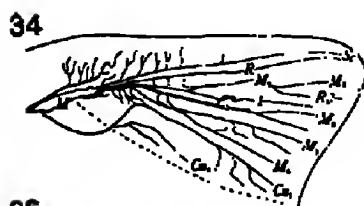
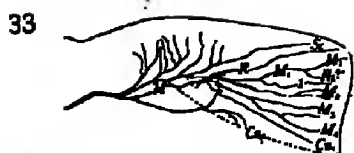
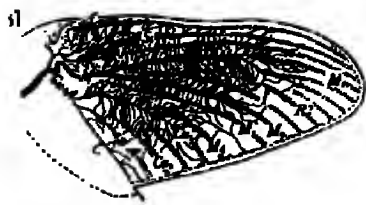
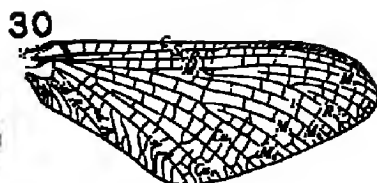
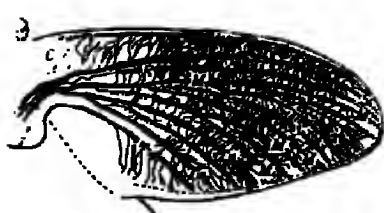
- Fig. 43. Hind wing-pad of *Chironomus albomaculatus* Needham.  
 " 44. " wing of "  
 " 45. " wing-pad of *Heptagenia* sp?  
 " 46. " wing of "  
 " 47. " wing-pad of " sp? (Nymph No. 3, Needham).  
 " 48. " wing of "  
 " 49. " wing-pad of *Epeorus humeralis* Morgan.  
 " 50. " wing of "  
 " 51. " wing-pad of *Callibaetis* sp?  
 " 52. " wing of "  
 " 53. " wing-pad of *Leptophlebia* sp?  
 " 54. " wing of "

## PLATE IX.

- Fig. 55. Wing of *Potamanthus luteus* (after Eaton).  
 " 56. " *Callibaetis humilis* "  
 " 57. " *Tricorythus* (Malay sp.) "  
 " 58. " *Stenophlebia* Trillies. "  
 " 59. " *Lachania abnormis* "  
 " 60. " *Oligoneuria rhenana* "  
 " 61. " *Elassoneuria Trimeniana* "  
 " 62. Fossil May-fly. Type of genus *Proterocisma* (after Sellards).  
 " 63. " " Wing of *Proterocisma rectus* "  
 " 64. " " Wing of *Proterocisma minus* "  
 " 65. " " Wing of *Proterocisma accuminatum* "  
 " 66. " " Wing of *Rekter arcuatus* "  
 " 67. " " *Baetis anomala* (after Pictet-Baraban and Hagen).



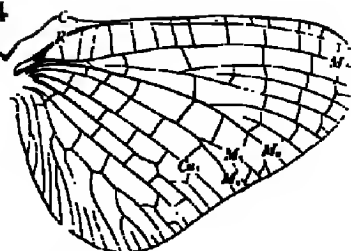




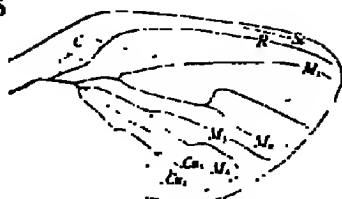
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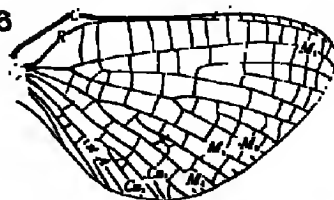
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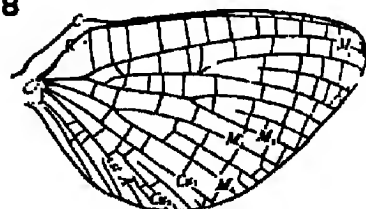
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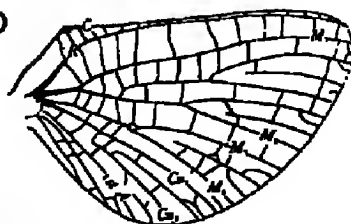
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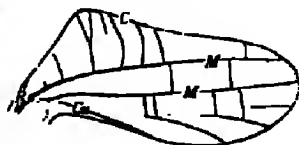
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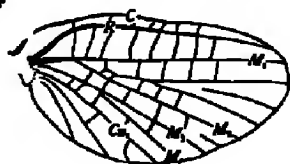
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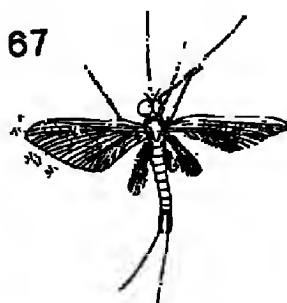
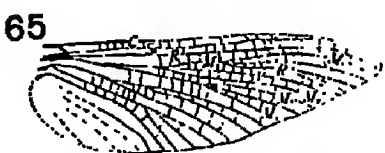
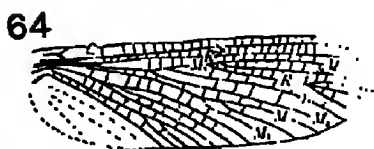
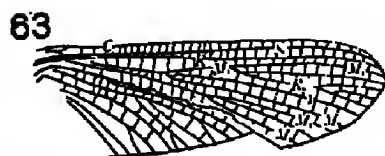
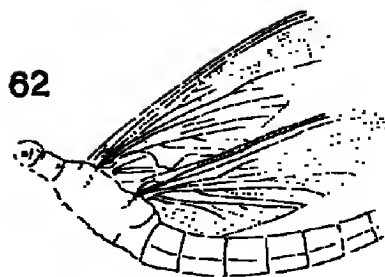
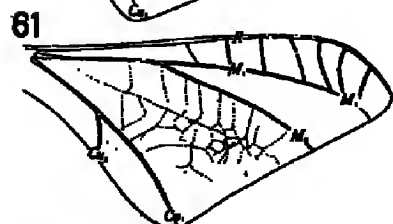
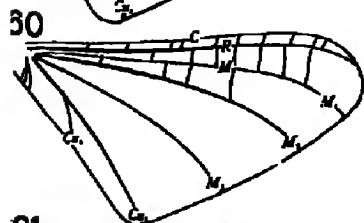
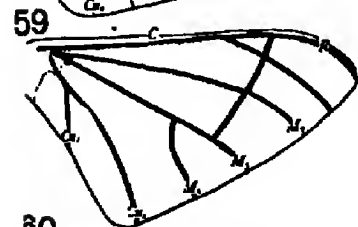
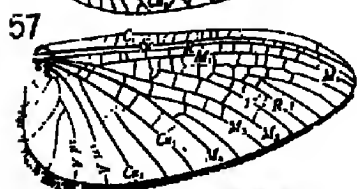
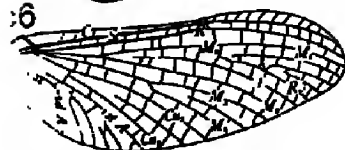
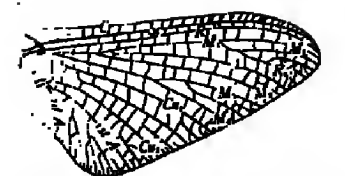


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In 1907 Schmiedeknecht<sup>2</sup> limited the tribe to only such Cryptines as are entirely wingless in the ♀ (none of which have an arcolated metathorax), and have no scutellum in this sex. This reduces the tribe to the following known genera.

*Thaumatotypus* Förster.

*Pezomachus* Grav.

*Pezolochus* Förster.

all of which are represented in North America.

Three species of the genus *Pezomachus* fall into a group so distinctive that I have proposed a sub-genus *Micromeson*, herein described, to include them.

The discarded genera of the tribe are now distributed as follows:

*Cremnodes*, *Apterophygus* and *Theroscopus* are now included in the genus *Hemiteles* Grav. and the genus *Hemimachus* is now sunk in *Pezomachus*; while the species of *Aptesis* are included some in *Microcryptus* Ratz. and some in *Hemiteles*.

There are no valid records of any of these genera, as they were then defined, being represented in America, with the possible exception of *Aptesis* the two described American species of which must now probably be included in *Microcryptus*. The three species placed in the genus *Cremnodes* by Ashmead and Harrington must be transferred to *Thaumatotypus*, while of the four species placed by Ashmead in *Theroscopus* three, namely *T. americanus*, *T. kukakensis* and *T. rufipes* belong to the genus *Pezomachus* while the fourth, *T. popofensis* was described from a single winged male and cannot therefore be, with certainty, placed in this genus.

The three genera of Pezomachini Schmied. can be separated as follows:

1. Second abdominal segment very large covering  $\frac{3}{4}$  of the entire length of the hind body, connate with the third segment. Petiole much longer than the metathorax..... *Thaumatotypus* Först.
2. Second abdominal segment not covering  $\frac{3}{4}$  of the hind body, not connate with the third segment. Petiole rarely much longer than the metathorax.<sup>2</sup>
2. Face much abbreviated..... *Pezolochus* Grav.
- Face of normal length..... *Pezomachus* Grav.

The subgenera of *Pezomachus* sens. lat. can be separated as follows:

- Prothorax much swollen in both sexes so that it is at least as long as the mesonotum along the median line. Petiole long and unusually slender. Subgenus *Micromeson*
- Prothorax not abnormally enlarged, shorter along median line than the mesonotum; petiole considerably expanded apically. Subgenus *Pezomachus*

<sup>2</sup>Die Hymenopteren mitteleuropas. Gustav Fischer, Jena. (1906).

Although I have only separated out this one subgenus of *Pezomachus* it is evident when one is working over a quantity of material that there are several well defined groups of species in this genus which would suggest that though the species, especially in the female sex are very similar, this genus may in reality consist of degenerate forms from more than one genus or even tribe. Unfortunately the species recognized in the male sex, which would probably have more distinctive characters, are much fewer than those now described in the female sex and in only nine American species have the males and females been correlated.

#### KEY TO THE SPECIES OF *Thaumatotypus*.

1. Antennae 18-jointed. .... 2  
Antennae 16-jointed; petiole striate, piceous species. .... *spinulatus* sp. nov.
2. Head and abdomen rufous, thorax testaceous. .... *canadensis* Harr.  
Not so coloured. .... 3
3. Petiole striate, metathoracic teeth acute ... .. *alaskensis* Ashm.  
Petiole smooth, or with median line, metathoracic teeth not prominent  
..... *tuberculatus* Ashm.

#### KEY TO THE NEW SPECIES OF *Pezomachus* HERE DESCRIBED.

##### FEMALES.

1. "Metathoracic" carina entirely absent; piceous species; length 4 mm. ... *P. utahensis*  
"Metathoracic" carina indented, either completely or only laterally. .... 2
2. Ovipositor not more than half as long as the petiole. .... 3  
Ovipositor at least about the same length as the petiole. .... 4
3. Antennae 18-jointed, abdominal pubescence dense; bicolored species  
ferruginous and black; length 3.5 mm. .... *P. brevistylus*  
Antennae 17-jointed, abdominal pubescence sparse, piceous species, length  
1.5 mm. .... *P. minutus*
4. Ovipositor not much longer or shorter than the petiole. .... 5  
Ovipositor  $1\frac{1}{4}$  times as long as the petiole; length of species 5 mm. .... *P. longistylus*
5. Abdominal pubescence rather long, moderately dense, antennae 17-jointed  
piceous species, length 2 mm. .... *P. robustus*  
Abdominal pubescence short. .... 6
6. Abdominal pubescence dense. .... 7  
Abdominal pubescence sparse. .... 10
7. Metathorax viewed from the side subconical, thorax fuscous, with black  
blotches, length 4 mm. .... *P. maculatus*  
Metathorax normal. .... 8
8. Petiolar spiracles so prominent that the general outline of the petiole is  
altered, sharply bi-colored species, head and abdominal apex black,  
remainder yellow. .... *P. coloradensis*  
Petiolar spiracles not at all prominent. .... 9
9. Meso- and meta-thorax sub-equal from above, densely pubescent. Black  
species, length 4.5 mm. .... *P. longipes*  
Mesothorax much shorter than "metathorax" the latter always with a  
median groove. .... *P. standfordensis*
10. Petiolar spiracles so prominent that the general outline of the petiole is  
altered. .... 11  
Petiolar spiracles only slightly prominent. .... 12

11. Spiracles on large thick conical projections; antennae 18-jointed, length of species 2.5 mm. .... *P. spiracul* 3  
Spiracles not exceptionally prominent; yellow-ferruginous species, with piceous bands on the abdomen; length 4.5 mm. .... *P. disp.*
12. Small species, 2.5 mm., antennae 21-jointed, petiole very short and broad. .... *P. pennsylvanic* 3  
Larger species, 1 mm. or more. .... 3
13. Ferruginous with third and following abdominal segments piceous, in sharp contrast to the rest of the body; length 4 mm. .... *P. simi* 3  
Ferruginous with fourth and following abdominal segments piceous; third piceous at base, but broadly ferruginous at apex. Length 5 mm. *P. nodos* 13

## MALES.

1. Wings fully developed. .... 2  
Fore wings partially developed, hind wings absent. .... *P. flavocinctus* Ashm. 2  
Wings absent. .... 4
2. Carina roughly semicircular. .... 3  
Carina sinuous, abdomen densely pubescent. .... *P. flavocinctus* Ashm. 3
3. Piceoferruginous species with the petiole and segments two and three luteous. .... *P. similis* 3  
Piceoferruginous species with well defined apical yellow bands on the petiole and second abdominal segment. .... *P. dispar*
4. Pubescence dense. .... 5  
Pubescence sparse. .... 7
5. Carina complete, sinuous. .... 6  
Carina incomplete, antennae about 22-jointed. .... *P. nigrofuscus*
6. Antennae about 29-jointed, fuscous species though abdominal segments often with narrow yellow apical bands. .... *P. flavocinctus*  
Antennae about 27-jointed, head thorax and petiole ferruginous, remainder of abdomen black. .... *P. manni*
7. Piceous black species with golden yellow legs. .... *P. auripes*  
Ferruginous species with a partially piceous abdomen. .... *P. ottawaensis* Harrington

SUB GENUS *Micromeson*.

## FEMALES.

1. Clear ferruginous species with piceous abdominal bandings. Face somewhat sunken between the eyes. Length 6-6.5 mm. .... *P. annulatus*
2. Fuscous species with piceous abdominal bandings. Face level with the eyes, length 6-6.5 mm. .... *P. lyomensis*
3. Pale honey yellow species, length 4 mm. .... *P. texanus* Cress.

*Thaumatotypus spinulatus*, sp. nov.

Female. Length 4 mm. Piceous black with very stout fuscous legs and antennae. Entirely clothed with rather sparse, long outstanding hairs. Petiole very long. Ovipositor stout.

Head from above transverse, this is due to its marked shallowness as it is but little wider than the thorax, rectangular, the margined vertex being slightly excavated; deep black and rather coarsely shagreened. Face rather long, greatly swollen below the antennae so that this portion projects beyond the eyes. Malar line indistinct, half as long as the width of the face at the lower corners of the eyes. Eyes small, about as long as the malar line, internal margins converging above. Clypeus transverse with a rather large deep fovea on either side. Mandibles testaceous, apparently bifid, teeth black. Antennae short and very stout, 16-jointed, as long as the head and thorax together, rather densely clothed with a short pubescence.

Thorax short and broad. Mesonotum piceous, similarly shagreened as the head, somewhat gibbous and with an obsolete median furrow. Indication of a scutellum. "Metathorax" black, strongly declivous anteriorly. Transverse carina incomplete medially but with the apophyses produced into extremely prominent projections, which gives the posterior face of the "metathorax" a concave appearance. There are two longitudinal carinae on either side. Surface rather coarsely shagreened and clothed with long white outstanding hairs.

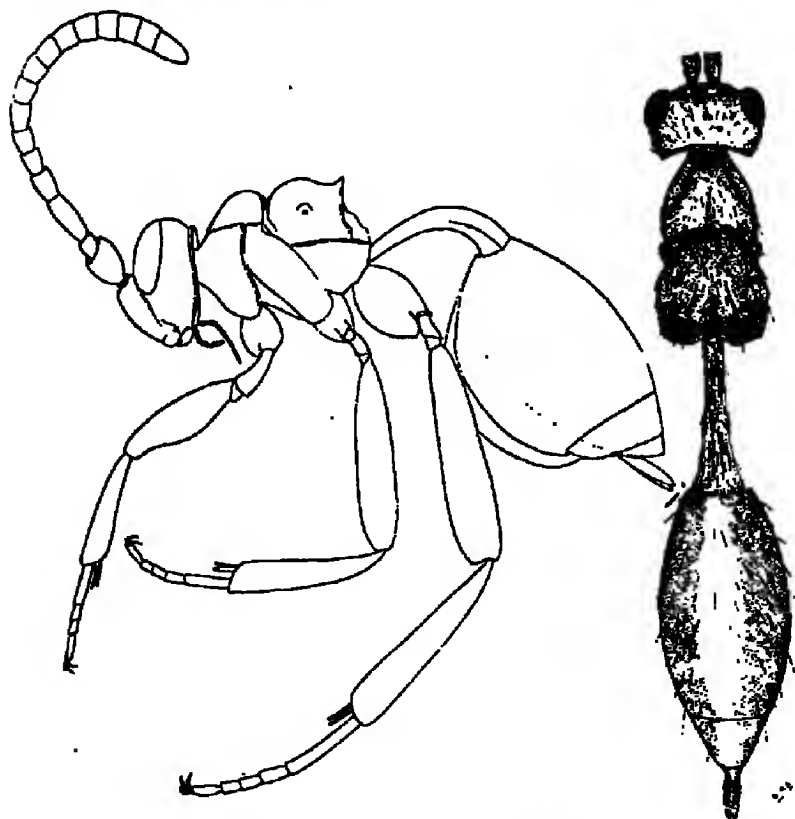


Fig. 1. *Thaumatotypus spinulatus*.

Petiole very long and not much expanded, as long as the thorax, strongly aciculate and with but slightly projecting spiracles. Remainder of abdomen elliptical, with the apex sharply pointed. Surface black, smooth and shining, with a sparse long pubescence. Second segment greatly enlarged, covering  $\frac{3}{4}$  of the length of the abdomen, the third segment covers most of the remainder. The apex of the fourth is all that is exposed of the remaining segments. There is an indefinite testaceous band near the apex of each segment. Viewed from the side the dorsal sclerites are seen to be much produced below the body of the

abdomen, and the free margins of the second segment meet on the ventral side of the abdomen. Ovipositor about as long as the third segment, sheaths stout, testaceous and densely pilose. Legs very stout and rather long. The swollen femora and tibiae are piceous black and are densely pubescent. The tarsi, which are quite normal in structure, are of a more rufo-testaceous color. Ungues simple.

Described from a single specimen taken at New Haven, Conn., by A. B. Champlain on the 20th of May, 1911.

I am rather doubtful as to the genus in which this species should be placed as in Försters description of *Thaumalotypus* he has "Scutellum distinct". In this species, however, the scutellum is not indicated.

As the generic description was drawn up on a single species and the present specimen agrees with it in all other particulars, notably in the much enlarged second abdominal segment, I have placed it provisionally here.

Schmeideknecht places the genus in the *Pezomachini* and it is probable that he has seen the type so it may be that Försters original description was not correct in this detail.

*Pezomachus utahensis* sp. nov.

Female. Length 4 mm. Head thorax and abdomen shining black. Antennae and legs piceous. Metathorax strongly gibbous, without a carina. Petiolar spiracles rather prominent.

Head, from above about twice as wide as thick along the median line, minutely punctulate, shining. Ocellar triangle small. Lateral ocelli nearer to the median ocellus than to the eye margins. Face entirely black, obtusely carinate medially from the insertion of the antennae to the base of the clypeus. Clypeus transverse, malar line obsolete, about half as long as the face is wide. Inner eye margins parallel and straight. Mandibles and palpi piceous. Antennae piceous above, lighter below, slender.

Thorax uniformly and closely punctulate, shining. Prothorax rather large, closely connate with mesothorax, suture obsolete; testaceous on median line. Mesothorax rather larger than metathorax, scutellum indicated by a rounded though rather large and prominent tubercle. Tegular tubercles prominent and testaceous. "Metathorax" strongly gibbous, posterior face abruptly declivous. Coxae black, remainder of legs piceous.

Petiole rather short and broad, evenly widened from the base to the apex except for where the rather prominent spiracles cause a small tubercle. Closely punctured, and with an obsolete median furrow. Remainder of abdomen oval, about  $2\frac{1}{2}$  times as wide as the thorax. Segments closely and evenly punctured, and with a sparse pubescence. Ovipositor about as long as the petiole, testaceous with fuscous sheaths.

*Observations.* Described from a single specimen taken at Park City, Utah. Type in the National Museum.

***Pezomachus brevistylus* sp. nov.**

Female. Length 3.5 mm., ferruginous, with apical half of the abdomen piceous; short and robust with a much abbreviated ovipositor; the body rather densely pubescent.

Head from above ferruginous, finely shagreened and pubescent, about twice as wide as thick along the median line. Antennæ short and 19-jointed; scape and first few flagellar joints ferruginous, remainder piceous, seventh and neighboring flagellar joints not quite twice as long as thick. Face below antennæ somewhat swollen, subtuberculate, clypeus semi-circular, indefinitely separated basally; malar lines distinct, about 1-3 as long as the face is wide at the lower angles of the eyes. Mandibles yellowish.

Thorax distinctly bi-nodose, ferruginous with a short rather dense pubescence. Scutellum hardly indicated, mesothoracic tegulae small but prominent; "metathoracic" carina poorly defined medially but prominent laterally. Legs ferruginous, hind legs infuscated at apex of the femora and over most of the tibiae.

Abdominal petiole short and broad, spiracles moderately prominent, surface ferruginous and shagreened; with a fine short pubescence; remainder of the abdomen short oval, second segment ferruginous, following segments piceous, surface punctulate, entirely clothed with a dense short pubescence. Ovipositor very short, about one-third the length of the short petiole; sheaths piceous.

*Observations.* Described from a single specimen taken at Philadelphia. Closely related to *P. ashmeadii* (*Cremnodes californicus* Ashm.), but readily distinguished by its color and more definite carina. Both of these species fall into a very distinctive group of *Pezomachini* the most distinctive characters of which are the shortened robust form of the body together with the much abbreviated ovipositor, and it is possible that these characters will be found to be of sub-generic value.

***Pezomachus minutus* sp. nov**

Female. Length 15 mm. Entirely piceous black, petiole short and broad at the apex. Ovipositor short.

Head transverse, temples swollen, about  $2\frac{1}{2}$  times as wide as thick along the median line. Surface polished though very finely punctured. Face below antennæ more coarsely punctured and hairy, produced forward immediately below the insertion of the antennæ, so that the latter are placed on a small horizontal ledge. Malar line distinct, about one-third the width of the face. Clypeus poorly defined, transverse. Mandibles and palpi piceous, concolorous with remainder of the face. Antennæ sub-clavate, piceous, entirely pilose, 17-jointed, reach to apex of petiole. Seventh and neighboring flagellar joints about  $1\frac{1}{4}$  times as long as wide.

Thorax not distinctly bi-nodose; uniformly and finely punctate. Scutellum entirely absent. Tegular tubercles very prominent. "Metathorax" as long as mesothorax, with a definite semi-circular carina behind which it is abruptly truncate. Legs not stout, concolorous with the thorax.

Petiole short, about  $\frac{3}{4}$  as broad as the apex is long; spiracles very prominent; finely and uniformly punctured. Remaining abdominal segments very shining, with a sparse pubescence and a very fine punctulation. Ovipositor short about  $\frac{1}{2}$  the length of the petiole, luteous with dusky sheaths.

*Observations.* Described from a single ♀ taken at St. Pauls Island. This species shows a relationship to *P. ashmeadii* and *P. brevistylus* in the shortened form and abbreviated ovipositor. Type in the National Museum.

***Pezomachus longistylus* sp. nov.**

Female. Length 5 mm. head and thorax ferruginous; abdominal segments piceous basally, yellowish apically. Ovipositor much elongate, about  $1\frac{1}{2}$  times the length of the petiole.

Head from above somewhat rectangular, the margined occiput but little excavated; surface shagreened and of a deep ferruginous color. Antennae longer than the head and thorax together, 24-jointed, slender; seventh and neighboring flagellar joints almost twice as long as thick; scape somewhat yellowish, apical third of flagellum piceous. Face ferruginous, rather long, malar lines distinct, about one-third as long as the face is wide at the lower angles of the eyes. Clypeus not very distinctly separated, mandibles yellowish with piceous teeth; labium prominent, yellow.

Thorax bi-nodose, somewhat slender, its surface evenly shagreened; scutellum poorly defined; "metathorax" somewhat gibbose, with a delicate complete transverse carina. Legs elongate ferruginous.

Abdominal petiole with prominent spiracles; width at apex about three times that at the base; surface finely shagreened, base ferruginous, apex yellowish; remainder of abdomen oval with surface finely shagreened and clothed with a sparse pubescence, all segments piceous basally, second segment yellow apically. On the third and following segments the yellow is gradually replaced by ferruginous. Ovipositor much elongated, almost  $1\frac{1}{2}$  times the length of the petiole, sheath piceous black.

*Observations.* Described from a single perfect specimen in the National Museum. Habitat and time of capture not noted. It somewhat resembles *P. micariae* Howard.

***Pezomachus robustus* sp. nov.**

Female, length 2 mm. A robust piceous species, with short, stout antennae and rather thick legs, "metathoracic" carina present but indefinite. No spiracular tubercles on the petiole.

Head large, from above rectangular, about twice as wide as thick of the median line; surface rather coarsely shagreened. Face swollen by the insertion of the antennæ, and of a lighter color than the thorax. Malar lines distinct, not quite half as long as the face is wide, between the lower angles of the eyes. Clypeus not very well defined orally, the free margin is almost semi-circular. The antennæ are short and stout, composed of 17 joints, of which the seventh and eighth flagellar joints are only slightly longer than wide. The basal joint of the antennæ is of a lighter brown colour than the head.

Thorax distinctly bi-nodose, clothed with a sparse pubescence, rather coarsely shagreened. The scutellum is absent. The "metathoracic" carina is poorly defined especially medially. The legs are short, not very long, and somewhat lighter in color than the thorax.

The abdominal petiole is short and evenly widened from the base to the apex, which is squarely truncate. The spiracles are not prominent. The surface is somewhat aciculate and dotted with an outstanding pubescence. Remainder of abdomen ovoid, shining, with a rather long pubescence. Ovipositor about as long as the petiole, with dusky sheaths.

*Observations.* Described from a single specimen taken at Tucson, Arizona, by H. G. Hubbard.

This species is similar in general appearance to a small *nigrellus* (Ashm.) but can be at once distinguished by the more robust form and shorter antennæ.

***Pezomachus maculatus* sp. nov.**

Female. Length 4 mm. Bicolored; ferruginous and black; head and abdomen, except petiole, black from above. Thorax mainly ferruginous, but with black blotches, especially on the pleuræ. Legs piceous with lighter colored patches. "metathorax" abnormally gibbous, indefinitely carinate. Thorax and abdomen densely pubescent.

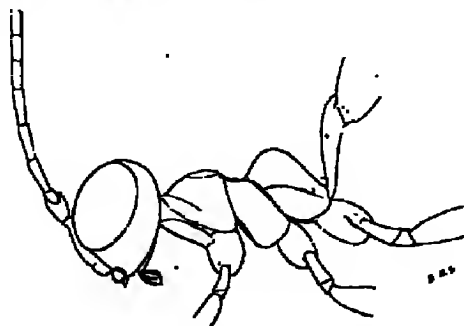


Fig. 2. *Pezomachus maculatus*.

Head from above coarsely shagreened; with small ocelli which are placed in a large equilateral triangle. The color is piceous black with flecks of dull ferruginous. Antennæ long and slender, 20-jointed, apex



piceous, base ferruginous, first three flagellar joints with basal and apical yellow bands. Face ferruginous, shagreened, transverse. Maxillary lines indistinct at eye ends, more prominent towards the clypeus, about one-third as long as the face is wide between the lower angles of the eyes. Mandibles rather yellowish, palpi piceous-black.

Mesothorax robust, rather short; with a well defined median sulcus, and a small obsolete scutellar tubercle. The surface is rather coarsely shagreened, and clothed with a moderately dense pubescence. The prevailing color is ferruginous, but there is a definite pre-scutellar piceous spot on the mesonotum, and the pleuræ have two piceous patches on both sides. The "metathorax" is very strongly gibbous; sub-conical, when viewed laterally; the carina is poorly defined. The surface is rather coarsely shagreened and clothed with a moderately dense pubescence. Anterior to the carina the "metathorax" is ferruginous, but on the posterior and lateral faces it is piceous. The legs are long, and piceous, for the greater part, but mottled with dusky yellow, which color is most prominent at the bases of the joints.

Abdominal petiole ferruginous, rather closely shagreened, and pubescent. The spiracles are prominent. Remainder of abdomen ovate deep black, and densely pubescent. Ovipositor long, 1 mm. sheaths piceous.

*Observations.* Described from a single specimen taken at Point Loma San Diego, California, by P. Leonard. Type in the collection of the Bussey Institution, Harvard University.

This is a very remarkable species which is readily distinguished by its abnormally convex "metathorax" and curiously mottled legs.

***Pezomachus coloradensis* sp. nov.**

Female. Length 4 mm. Ovipositor .75 mm. Very distinctly bicolored species as follows: Head black, entire thorax, legs, petiole and second and third abdominal segments light ferruginous; remainder of abdomen black.

Face ferruginous below the insertion of the antennæ, and slightly so above, along the eye-margins. Mandibles yellow at the base, apical half ferruginous, teeth black. Palpi yellow. Antennæ dusky above rather more yellowish below, rather long and slender with seventh flagellar and neighboring segments about  $1\frac{1}{2}$  times as long as wide. Head from above shagreened, slightly pilose, transverse, over twice as broad as thick along the median line.

Thoracic nodes sub-equal. Mesothorax with a poorly defined median furrow, most distinct just before the slightly raised scutellar area. The "metathoracic" carina which is broadly hastate in form is poorly defined except laterally. The legs, especially the hind ones, are rather more dusky than the thorax.

The petiole is about three times as wide at the apex as it is at the base, but does not widen much after the rather prominent spiracles, it is

slightly constricted immediately behind these; the entire surface is finely and evenly punctured. The remainder of the abdomen is oval, finely and evenly punctured with a short but rather dense pubescence. Segments 2 and 3 are sub-equal in length and sharply contrasted in color with the remaining black segments. The ovipositor and sheaths are piccous.

*Observations.* Described from a single ♀ specimen taken in Colorado. Type in the National Museum.

***Pezomachus longipes* sp. nov.**

Female. Length 4.5 mm. Piccous black, densely pubescent, species. Legs very long and slender.

Head from above about twice as wide as thick along the median line, piccous, surface shagreened, not shining, ocelli very small. Antennæ piccous throughout, slender but rather short, 23-jointed, the 7th and neighboring flagellar joints not quite twice as long as thick. Face below antennæ somewhat swollen, piceo-ferruginous, clothed with a rather long pubescence, especially on the clypeus. Clypeal suture obsolete. Malar lines distinct, about half as long as the face is wide at the lower angles of the eyes. Cheeks not swollen.

Thorax piccous black, uniformly shagreened, about three times as long as wide, nodes sub-equal. Mesothorax densely pubescent, tegulae small but prominent, no indication of a scutellum. "Metathorax" more sparsely pubescent and more shining than the mesothorax. The carina is sinuous and poorly defined medially. Legs long and slender, the hind femora reaching almost to the apex of the abdomen, piccous black and clothed with a dense short pubescence.

Petiole piccous black with an indefinite and variable ferruginous apical band, densely pubescent, evenly widened from the base to the apex, spiracles not prominent. Remainder of abdomen ovate, black, sub-shining though closely punctate and clothed with a dense short pubescence. Ovipositor and sheaths black, somewhat longer than the petiole.

*Observations.* Described from two specimens taken at Stanford University, California, by William M. Mann, Feb., 1910, and Harold Morrison, Dec., 1910. This species resembles *P. cockerelli* Bruce but is readily separated by the presence of the metathoracic carina.

Type in the collection of the Bussey Institution, Harvard University.

***Pezomachus stanfordensis* sp. nov.**

Female. Length 4 mm. Shining black, antennæ, legs, mesothorax and extreme apex of petiole usually lighter in color. Abdomen with a rather dense pubescence. "Metathorax" and usually mesothorax also, with an obsolete median furrow.

Head from above quadrate, temples somewhat narrower than the eyes, rather less than twice as broad as thick along the median line; surface dull black, finely shagreened. Ocelli small, lateral ones nearer the median ocellus than to the eye margins. Antennae stout 19-jointed, the seventh and neighboring flagellar joints hardly longer than thick, color ferruginous to dusky with the apex piceous. Face below antennae short, with the distinct malar lines about a quarter as long as the face is wide at the lower angles of the eyes, mainly ferruginous but with a piceous spot on either side between the bases of the antennae and the malar line. Clypeal suture poorly defined. Mandibles ferruginous with piceous teeth.

Thorax short and shining though finely shagreened and with a sparse pubescence. Mesothorax piceous, much shorter than the black "metathorax", usually with a poorly defined median furrow. Scutellum not indicated. "Metathorax" with a complete though not very prominent carina, and with a more definite median furrow than on the mesothorax. Legs not very long, rather densely pubescent, color variable from light dusky to piceous black, in the latter case the joints between the coxa and trochanter, and the trochanter and femora, are distinctly lighter than the remainder of the leg.

Petiole piceous black, not very elongate, evenly expanded to the apex which is sometimes indefinitely ferruginous. Spiracular tubercles absent. Remainder of abdomen ovate, shining black, sometimes with apices of all segments slightly tinged with clear ferruginous, rather densely pubescent on the second and third, but more sparsely on the remaining segments. Ovipositor and sheaths piceous, about as long as the petiole.

*Observations.* Described from two specimens taken by William M. Mann, at Stanford, Cal., on Nov. 23, 1909, and Jan. 5, 1910.

This species resembles *Pezomachus obsesus*, Ashm. but is larger and stouter and has a very much shorter mesothorax.

Type in the collection of the Bussey Institution, Harvard University.

#### *Pezomachus spiraculus* sp. nov.

Female. Length 2.5 mm. A small robust species, piceous black, except for the antennae, pro- and mesothorax, legs and petiole, which are dusky ferruginous. Petiolar spiracles abnormally prominent, placed on stout tubercles. "Metathorax" carinate.

Head from above not transverse, piceous and rather coarsely shagreened. Antennae 18-jointed, fuscous basally, piceous at the apex, short and stout, with the seventh and neighboring flagellar joints about one and a half times as long as thick. Face swollen below the insertion of the antennae, malar lines black, not quite half as long as the face is wide at the lower angles of the eyes, the inner margins of which diverge slightly below the insertion of the antennae. Clypeus normal. Mandibles lighter in color than the rest of the face, with black teeth.

Thorax robust, binodose, with the nodes unequal and similar. Mesothorax fuscous somewhat gibbose, with no scutellum indicated. Its surface is coarsely punctulate. "Meta-thorax" piceous, strongly gibbose, with the carina indistinct medially, but well defined laterally; it is sharply declivous behind the carina and this portion bears two longitudinal carina on each side. Surface dull and coarsely shagreened before the carina, but shining behind. The legs are stout and dusky.

The petiole is dusky and very stout. It is flattened dorsally and is somewhat aciculate, laterally are two very prominent tubercles which bear the spiracles. The remainder of the abdomen is ovate, piceous black and shiny, with a sparse pubescence. Ovipositor ferruginous with piceous sheaths; about the same length as the petiole.

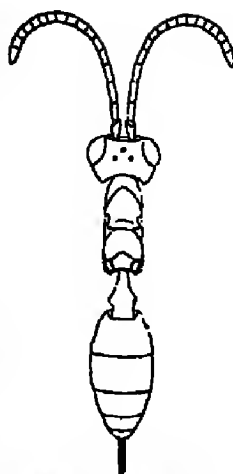


Fig. 3. *P. spiraculus*.

**Observations.** Described from a single specimen taken at Round Knob, N. Carolina.

This species is easily recognized by its abnormally large petiolar tubercles. Type in the National Museum.

***Pezomachus dispar* sp. nov.**

Three specimens, 2 ♂♂ and 1 ♀ of undescribed species of *Pezomachus* were bred from a spider's egg capsule taken at Twining, Maryland. The ♀ differed considerably in color from the ♂♂ but this appeared to be an insufficient reason for disassociating the sexes. It is proposed however to make the ♂ the type of the species, placing the ♀ provisionally with it till further evidence determines whether this is a valid correlation or not.

**Male.** Length 5.5 mm., fully winged; slender, head, thorax and abdomen piceous except for a divided ferruginous spot on the anterior portion of the mesothorax and yellowish apical bands on the first three abdominal segments. Legs dusky yellow.

Head from above transverse, piceous though more ferruginous round the eye margins; ocelli large, antennae long and slender, 27-29-jointed; yellowish at base, mainly dusky. Face below antennae ferruginous, malar lines distinct short, about  $\frac{1}{2}$  to  $\frac{3}{4}$  as long as the face is wide at the lower angles of the eyes. Mandibular teeth transparent, palpi dusky.

Mesothorax well developed, surface shagreened, rather coarsely on disc, more finely laterally; clothed with a short pubescence. Parapsidal furrows well defined anteriorly, the space between them is of a fer-

ruginous color except for a narrow median piceous line; remainder of thorax piceous. Scutellum and wings well developed. "Metathorax" rather coarsely shagreened with a well defined semi-circular carina. Legs, including coxae dusky luteous.

Abdominal petiole long and slender, but little expanded at the apex; spiracles prominent; piceous, with a definite yellow apical band. Remainder of abdomen slender, second segment with a broad apical yellow band, third segment with or without a definite apical band. Remaining segments entirely piceous and more shining. Surface shagreened, with a rather long pubescence. Claspers small.

Female. Length 4.5 mm. Yellow ferruginous except for narrow indefinite basal bands on the abdominal segments.

Head from above somewhat transverse, ferruginous, but more yellowish round the eye margins. Antennae (broken) long and slender, the scape and first three flagellar segments are luteous. Face below antennae swollen medially. Malar lines distinct, about one-third as long as the face is wide at the lower angles of the eyes; mandibles yellowish with piceous teeth, palpi yellow.

Thorax yellow ferruginous evenly shagreened, about  $2\frac{1}{2}$  times as long as wide. Mesothorax with an obsolete median furrow and no indication of a scutellum. "Metathorax" somewhat gibbose with a delicate but complete carina, which is most definite laterally. Legs dusky luteous.

Abdominal petiole with rather prominent spiracles, apex almost three times as wide as the base, surface finely shagreened, color ferruginous, more yellow at apex. Remainder of abdomen oval, segments piceous at the base merging through ferruginous to honey-yellow at the apex, clothed with a moderately sparse pubescence. Ovipositor elongate luteous, sheaths dusky at the apex.

The ♀ is much like that of *micaria* How. but is lighter in color and has more prominent petiolar spiracles.

Type of ♂, and ♀ from which this description is drawn, in National Museum.

***Pezomachus pennsylvanicus* sp. nov.**

Female. Length 2.5 mm. A small, slender, fuscous species, with a very short and broad petiole. Antennae rather long and slender. Ovipositor as long as the petiole.

Head from above rather globose though the occiput is excavated. Surface coarsely rugose. Ocelli small. Face rather broad, malar line distinct, about one-third as long as the face is wide. Antennae 21-jointed; seventh and neighboring flagellar joints about  $1\frac{1}{2}$  times as long as wide. Color fuscous throughout. Clypeus not very well defined. All mouth parts colored as the rest of the head, but mandibular teeth rather more piceous.

Thorax uniformly fuscous, nodes sub-equal. Mesothoracic tegulae prominent. No indication of a scutellum. "Metathoracic" carina poorly defined, but the somewhat gibbous metathorax is abruptly declivous behind its situation. Legs uniformly rufous brown.

Petiole rather yellow at the apex, short, about  $1\frac{1}{4}$  times as long as broad at the apex. Base broad, but not half the width at the spiracle. Second abdominal segment which the petiole widens but little. The spiracles are not very prominent. Remainder of the abdomen elongate oval, uniformly brown with a sparse short pubescence. Ovipositor as long as, or slightly longer than, the petiole. The surface of the abdomen, including the petiole, shining and only shallowly shagreened.

*Observations.* Described from a single bred specimen collected by Kirby and Champlain at N. Cumberland, Pa., 11-27-'09

***Pezomachus similis* sp. nov.**

The female measures about 4 mm., stout, ferruginous except for apical half of the abdomen which is shining picceous. "Metathoracic" carina indistinct, though apophyses are prominent. Abdominal pubescence sparse.

The male measures about 5 mm. long and slender, fully winged in all specimens seen. The head thorax and legs ferruginous as in ♀, but the petiole and at least the second and third abdominal segments are luteous, remaining segments picceous as in ♀. Metathoracic carina distinct, semi-circular. Abdominal pubescence rather dense.

Female. Length 4-4.5 mm. Head from above ferruginous and finely shagreened; about twice as wide as thick along the median line. The margined occiput is not very deeply excavated. Ocelli small and rather far apart, the lateral ones are about as far from the median as from the eye margins. Antennæ long and slender, entirely ferruginous, 23-jointed. Face rather transverse, malar line not very distinct, about one-third as long as the face is wide at the lower angles of the eye margins. Clypeus transverse, mandibles rather flavous at the base, with two shining rufous apical teeth. Palpi ferruginous.

The thoracic nodes are sub-equal, the surfaces are shagreened and sparsely pubescent. Mesothorax with a distinct median groove. Scutellum indicated by a small rounded tubercle. "Metathorax" rather gibbous, the carina is poorly defined medially, but the apophyses are distinct and appear as two short horizontal lines. Legs long, dusky-ferruginous.

Petiole and second abdominal segment ferruginous, the remaining segments are picceous. The entire surface is finely shagreened and shiny, with a sparse short pubescence. The petiole is about  $3\frac{1}{2}$  times as broad at the apex as at the base. Spiracles sub-prominent. Ovipositor ferruginous. Sheaths picceous except at the base where they are yellowish.

Male. Length 5 mm. Head from above transverse, about  $2\frac{1}{2}$  times as wide as thick along the median line. Ocelli very large. The occiput is not very deeply excavated. The antennæ are slender and as long as the body, about 28-jointed. Face similar to that of the ♀ but the clypeus is deeper and therefore less transverse.

Thorax entirely ferruginous. The mesothorax is well developed with distinct parapsidal grooves on its apical half, which slightly converge caudad. The surface is finely shagreened with a short, not very

sparse pubescence. The scutellum is large. "Metathorax" rather small and flat with a well defined roughly semicircular carina, and rather prominent straight lateral carinae. Wings well developed. Legs long and slender, ferruginous.

Abdomen elongate and slender. Petiole and segments 2 and 3 and sometimes part of segment 4 luteous; remainder piceous. Surface shagreened, with rather a dense pubescence. Petiole long and slender, but little dilated at the apex which is only about  $1\frac{1}{2}$  times as wide as the base, spiracles rather prominent. Genital claspers small.

Types in the National Museum.

Described from 4 ♀ and 5 ♂ bred from egg capsules of *Algalena navia* taken at Twining, Maryland, issued Feb. 14 and 15th.

The females are much like those of *P. flavocinctus* Ashm. but have less pubescent abdomens and only 25 joints to the antennae.

*Pezomachus nodosus* sp. nov.

Female, length 5 mm. Color ferruginous with metathoracic disc, base of the third abdominal segment, the whole of the fourth and remaining segments piceous. "Metathoracic" carina complete, not prominent.

Head from above about twice as wide as thick along the median line, surface finely shagreened, occiput rather deeply excavated. Ocelli small, lateral ones about equidistant from the median ocellus and the eye margins. Antennae long and slender, at least 21-jointed (broken) rather more dusky in color than the rest of the head. Seventh and neighboring flagellar joints about  $2\frac{1}{2}$  times as long as wide. Face not transverse, cheeks rather swollen; malar line distinct, about one-third as long as the face is wide between lower angles of the eyes. Clypeal suture not very definite. Mandibles ferruginous with piceous teeth. Palpi long and ferruginous.

Thorax rather coarsely shagreened, with a sparse pubescence. Mesothorax elongate, with a broad shallow median furrow and a vaguely defined scutellum. "Metathorax" gibbose, declivous both anteriorly and posteriorly, rather more piceous than the mesothorax on the disc. Carina complete but not very prominent. Legs long and rather fuscous.

Petiole not very elongate, about three times as wide at the apex as at the base, spiracles sub-prominent. Remainder of abdomen ovate. Second segment rather yellow-ferruginous at apex, third piceous at base. The remaining segments and ovipositor sheaths are piceous. The entire surface of the abdomen is shining, obsoletely shagreened and with a sparse pubescence.

*Observations.* Described from a single specimen taken at Lawrence, Kansas, by Hugo Kahl, on June 19th, 1896. It somewhat resembles *P. ottawaensis*, Harrington in color and the form of the carina, but is much more binodose.

Type in the National Museum.

***Pezomachus flavocinctus* Ash.**

2 Proc. U. S. Nat. Mus. Vol. 12, p. 421.

The male of this species is polymorphic, the specimens seen however fall into two main categories, namely (1) winged (2) wingless, while a single specimen was found in which the mesothoracic wings were present, but much smaller than normal, while the metathoracic wings were entirely absent.

There is very little uniformity in details in this species but in general appearance and color members of both categories are very similar.

The most constant characters are:

1. The antennae, which are long and slender, and always about 29-jointed.
2. The general shape of the head, which is about twice as broad as thick along the median line, is finely shagreened and has a sparse pubescence. The ocelli however, are inconstant in size.
3. The "metathoracic" carina. This is not very prominent but is always somewhat as shown in the figure, though it may be less angular.
4. The legs are all rather long and slender, with very small simple ungues.
5. The abdomen is densely pubescent in all forms and is mainly fuscous in color. The petiole and following two or three segments may have dull yellow apical bands.

The most inconstant characters are:

1. Ocelli. These are usually large in winged forms and quite small in wingless forms, but this correlation is not entirely constant.
2. Mesothorax. The development of this varies immensely with the presence or absence of wings. The "scutellum" also is very large in winged forms, but tuberculate in wingless forms.
3. The petiole. The spiracles may be, and usually are, tuberculate, but in some specimens they are hardly if at all prominent. This is in no way correlated with the presence or absence of wings.
4. The size of the individual. Winged forms are typically the larger and vary in length from 4.5-5 mm. Some specimens however, are much more slender than others. The wingless forms vary from 3.5 to 5 mm. in length. They are all slender, but some are more so than others.

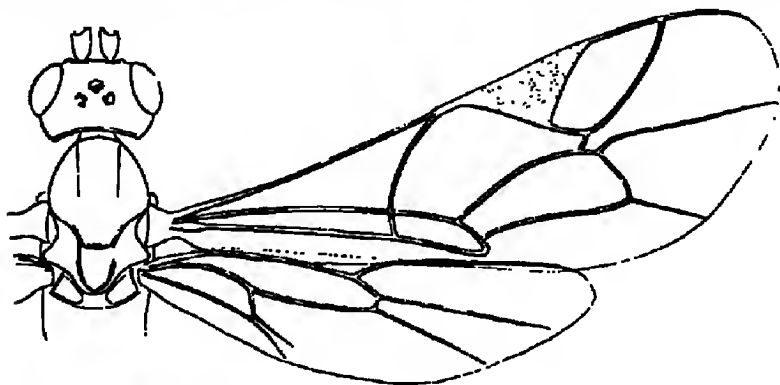
**Typical winged form.**

Length 4.5 mm. Fully winged. Color mainly fuscous, but abdominal segments may have narrow yellow apical bands. Pubescence short and dense especially on the abdomen.

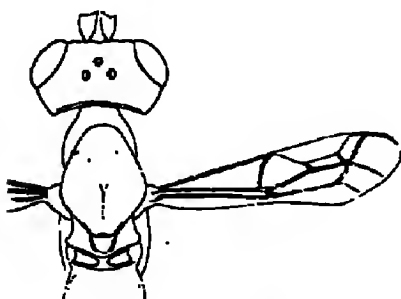
Head from above finely shagreened, about twice as wide as thick along the median line. Occiput not very deeply excavated. Ocelli usually very large, placed on a somewhat raised triangle. The lateral ocelli nearer to the median than to the eye margins. Antennae long and slender, about 29-jointed; apex picuous, in some specimens this color extends almost to the base. Seventh and neighboring flagellar segments about  $2\frac{1}{2}$  times as long as broad. Face rather lighter in color than the vertex. Malar line distinct about  $\frac{1}{2}$  to  $\frac{3}{4}$  as long as the face is wide as the lower end of the parallel inner eye margins. Clypeus transverse with a distinct basal fovea separating it from the remainder of the face. Mandibles bidentate, concolorous with, or a little more yellow than, the remainder of the head. Teeth somewhat darker. The face may have a longitudinal median swelling running from the insertion of the antennae to the base of the clypeus, at which point it is widest.



Mesothorax well developed and rounded, with more or less well defined parapsidal grooves. Surface finely and evenly shagreened and clothed in a rather dense short pubescence. Color rather variable, mainly dark fuscous. The space between the parapsidal grooves may be of a somewhat lighter color than the lateral portions and there may be a distinct still lighter median line. Scutellum very large and well defined. Wing veins testaceous. The brown stigma has a very conspicuous white basal spot which extends on to the costa. "Metathorax" with a distinct complete hind carina. Surface rather more coarsely



Fully Winged ♂



♂ with Vestigial Wings



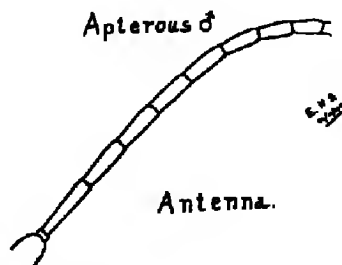
Apterous ♂



Types of Petiole



Metathoracic Carina



Antenna.

Fig. 1. *Pezomachus flavocinctus*.

vened than that of the mesothorax, especially behind the carina; venation more sparse, especially on the disc, but distinctly longer. Legs long and slender, rather lighter in color than the thorax. Fore and middle legs inclined to be testaceous. Petiole long and slender with rather prominent spiracles, behind which the sides are parallel. Remainder of abdomen slender, terminating with broad testaceous claspers. The color of the abdomen is variable, but is mainly fuscous; the petiole and wing two or three segments may have dull yellow or whitish apical spots. The entire surface is closely punctulate and covered with a rather dense pubescence.

*Observations.* Described from 22 specimens taken at Twinning, Maryland.

**Form with rudimentary wings.**

Head, "metathorax," legs and abdomen as in winged form. Mesothorax reduced in size; with a much smaller scutellum. The poorly defined parapsidal grooves are widely separated anteriorly but meet at about the middle of the mesonotum continuing to the scutellum as a single median shallow groove. They thus resemble together the letter *Y*. Mesothoracic wings small, extending to about the middle of the second abdominal segment. They were much crumpled in the specimen but the venation was apparently not very abnormal. The arcolet was missing and there was an extra recurrent vein from the somewhat distorted stigma. The metathoracic wings were entirely missing.

*Observations.* Described from a single specimen from Twinning, Maryland. This specimen was bred from an egg nest from which also emerged, one fully winged male, one apterous male and one female.

**Wingless form.**

Similar to winged forms except for the mesonotal structure. The axilli also are always small. Mesonotum much narrower than the head, with a tuberculate scutellum. Parapsidal grooves, may be slightly separated anteriorly, usually only visible as a shallow posterior depression. The surface of the mesonotum is pubescent as in the winged form.

*Observations.* Described from about 30 specimens taken at Twinning, Maryland, and from one taken at Cornell.

On an average these are much smaller than the winged forms which would suggest that their apterous condition is in some way connected with an insufficiency of food.

Both types of male were often bred from the same cocoon together with females which are much more constant in form than the males.

Types in the National Museum.

Paratypes (except brachypterous form) in the Bussey Institution, Harvard University.

The breeding labels show that the majority of these hatched out during the latter part of February, March and the first half of April, extra notes were given on three labels as follows:

1. "From egg capsule of *Prothesima* sp. Twining City, Md. iss. Dec. 28th, 1897. A. Busck coll."  
The pin bore two wingless males.
2. "♀ iss. Feb. 22, 1898, laid same date one egg unfertilized. From this time issued April 21, 1898. A. B."  
The pin bore 1 ♀ and 1 fully winged ♂.
3. "♀ issued Feb. 11, 1898. Oviposited unfertilized; male from the eggs issued April 20, 1898. A. B."  
The pin bore one ♀ and one fully winged ♂.

This appears to be the only case of dimorphism in ♂ *Pezomachini* as yet noticed in this country, but there can be no doubt that this is perfectly valid, and it is probable that similar conditions will be found to exist in others of the species already described in one form, or in both forms under different names.

The condition of small mesothoracic wings being present, while the metathoracic wings are entirely suppressed as found in the intermediate form, is almost unique in the Hymenoptera. As far as I am aware the only analagous case is seen in ants. Professor Wheeler (Ants, their Structure, Development and Behavior, pp. 99 and 102) described and figures abnormal ant workers and soldiers, which he terms *Pterergates* in which mesothoracic wing rudiments have developed. In the Braconidae, Chalcidoidea and Proctotrypoidea where forms with rudimentary wings are occasionally met with, and the mesothoracic wings are often reduced far more than in the species under consideration, it is always found that metathoracic wings are also present.

A *Hemiteles* sp. (hyperparasite ?) was in several instances bred out from the same egg capsules as this species.

***Pezomachus manni* sp. nov.**

Male. Length 4 mm. Wingless. Head, thorax and petiole ferruginous, remainder of abdomen black. Antennæ and legs piceous.

Head from above dusky ferruginous, finely rugose and with a very sparse pubescence. The small lateral ocelli are a little nearer to the median ocellus than to the eye margins. Antennæ piceous reaching to about the apex of the second abdominal segment, about 27-jointed, seventh and neighboring flagellar joints twice as long as thick. Face below antennæ ferruginous, malar lines distinct, short, hardly more than  $\frac{1}{4}$  as long as the face is wide at the lower angles of the eyes. Clypeus transverse, truncate. Palpi dusky.

Thorax elongate and cylindrical, ferruginous, mesothorax and portion of "metathorax" behind the carina dusky ferruginous; surface greened, with a very sparse pubescence. Wing rudiments white, scutellum tuberculate. "Metathoracic" carina complete but poorly defined, feebly sinuous. Legs elongate and fuscous basally, all tarsi black, fore and hind-femora and tibiae piceous.

Petiole but little expanded, elongate, ferruginous, finely shagreened and sparsely pubescent. Spiracles sub prominent. Apex about twice as long as the base, and one-third the length of the petiole. Remainder of abdomen elongate, black, rather coarsely shagreened and with a moderately dense pubescence. Claspers small.

*Observations.* Described from a single ♂ specimen taken by Mr. William M. Mann from the nest of *Formica subpolita* Mayr. at Pacific Grove, California, June, 1909.

This species much resembles *P. macer* Cress. but has much shorter antennae and the abdominal coloring is quite distinctive. From *P. ottawensis* Harr. it is distinguished by the much more elongate petiole, and differently colored abdomen.

***Pezomachus nigrofuscus* sp. nov.**

Male. Length 4.5 mm. wingless, slender; head black, thorax and petiole fuscous; remainder of abdomen black with the exception of an apical yellow band on the second segment, moderately dense pubescence.

Head from above black, finely rugose and with a moderately dense pubescence; the small lateral ocelli are as far from the median ocellus as from the eye margins. Antennae about 22-jointed, scape fuscous; flagellum piceous above, but with numerous small silvery longitudinal lines on each segment, which have the appearance of white hairs. Ventrally the fifth to the ninth flagellar segments are somewhat fuscous. Face below the antennae somewhat swollen and lighter in color, malar lines distinct, short, hardly more than one-fourth as long as the face is wide at the lower angles of the eyes. Clypeus and cheeks piceous; mandibles yellowish with piceous teeth.

Thorax long and cylindrical, entirely fuscous, "metathorax" somewhat darker than the mesothorax, and more sparsely pubescent. Wing rudiments large and white; scutellum tuberculate; "metathorax" rather coarsely shagreened, carina incomplete on median area but well defined laterally, fore and mid-legs entirely fuscous, hind femora and tibiae more piceous.

Petiole but little expanded, spiracles not very prominent, surface shagreened, with a sparse pubescence, color fuscous with an indefinite yellowish apical band. Remainder of abdomen slender, piceous black, except for a yellow apical band on the second segment, surface rather coarsely shagreened and with a moderately dense pubescence. Claspers small.

*Observations.* Described from a single ♂ specimen taken at Philadelphia. Similar to *P. urbanus*, Brues, but smaller and distinguished by the dense abdominal pubescence.

Type in the National Museum.

***Pezomachus auripes* sp. nov.**

Male, length 3.5–4 mm., wingless. Shining black, with bright yellow legs.

Head from above rectangular, not transverse; occiput but slightly excavated, ocelli small. Antennae about 21-jointed, piceous black, seventh and neighboring flagellar joints about twice as long as thick. Face shining black, closely and evenly shagreened, with a short whitish pubescence. Mandibles and palpi testaceous; malar line obsolete, about one-third as long as the face is wide.

Thorax finely and evenly shagreened, with a moderately sparse short pubescence; scutellum well defined, flat dorsally; tegulae yellowish white. "Metathorax" with a well defined carina. Legs long and slender, bright yellow including the coxae. Tarsi rather more dusky. Abdominal petiole short, closely and finely shagreened, with an even sparse pubescence. Spiracular tubercles absent. Remainder of abdomen shining, finely shagreened, sparsely pubescent, elongate oval, terminating with two much enlarged piceous black claspers.

*Observations.* Described from a single damaged specimen taken at St. Pauls Island, Alaska, by T. Kincaid (Harriman Expedition).

This is a very pretty and distinctive species; it much resembles Ashmead's description of *P. obesus* ♀ (Proc. Wash. Acad. Sci. Vol. 4, p. 192) drawn up from a female specimen taken in the same locality, and it seems probable that it will be found to be the male of this species.

Type in the National Museum.

***Pezomachus ottawaensis* Harrington.**

Female. Can. Ent. Vol. 28, p. 77.

Male, 5 mm. long, wingless. Head and thorax dull ferruginous, abdomen piceous with ferruginous petiole and similarly colored apical band on the second segment.

Head rather large, from above somewhat quadrate, finely shagreened with a short sparse pubescence, uniformly ferruginous, about twice as wide as thick along the median line. Antennae long and slender, about 25-jointed. Pedicel and first two or three flagellar joints ferruginous, remaining joints piceous black. Malar line indistinct, short, about one-third as long as the face is wide at the lower angles of the eyes, eye margins parallel. Clypeus well defined; mandibles rather more yellowish than remainder of head; teeth piceous.

Thorax narrow, ferruginous, closely and evenly shagreened, sparse pubescence. Mesothorax rather strongly margined, with a shallow median furrow. Scutellum tuberculate. Tegulae white. "Pothoracic" carina angular, (i. e., not semi-circular or sinuous) well defined at the sides, but less distinct medially. Legs rather more dusky-ferruginous than the thorax, especially dark on the hind tibiae. Abdominal petiole short and broad, typically ferruginous, but dusky in some specimens, as a rule without prominent spiracles, these however, may be placed on small projections, surface shagreened and sparsely pubescent. Remainder of abdomen narrow oval, piceous black except for a ferruginous apical band on the second segment; surface finely shagreened and with a sparse pubescence. Claspers piceous, rather small.

*Observations.* Described from six specimens bred from spiders nests taken in Connecticut (Linn, New Haven and Ridgefield) and from three specimens bred from a single nest taken in Pennsylvania (N. Cumberland).

Although these specimens were never actually bred out from the same nests as ♀ *ottawensis* (Harrington) they were bred from nests taken from the same places as nests yielding specimens of the named female, and owing to their striking similarity in color and petiolar form there can be no doubt that they represent the ♂ of this species.

The specimens from which these were described have been sent to the State Entomologist, New Haven, Connecticut.

A winged specimen has been reported<sup>4</sup> as the male of this species but no complete description was drawn up. The only data given was in the specific tables where the following identification characters were given, "Winged". "Black with segments two and three of abdomen yellowish". It would seem that this correlation was incorrect since such a male must be very unlike the ♀. The origin of this report cannot, unfortunately, be traced.

***Pezomachus ashmeadii* nom. nov.**

***Cremnodes californicus* Ashm.**

The female of this species, described by Ashmead as *Cremnodes californicus*, Proc. Nat. Mus. Wash. Vol. XII, p. 420 (1889) is entirely wingless, and has no scutellum. Since Förster in his original description of the genus *Cremnodes* states "Der Mitteleib mit Flügelrudimenten und abgesetztem Schildchen...." this species must be removed to the genus *Pezomachus* in which the specific name "californicus" is preoccupied.

<sup>4</sup>C. T. Brues, Trans. Amer. Ent. Soc., Vol. XXIX, pp. 120 and 121.

***Pezomachus bruesii* nom. nov.*****Pezomachus obesus* Brues.**

The specific name "obesus" proposed by Brues (Bull. W. Nat. Hist. Soc. Vol. VIII, No. 2, p. 68) for a Massachusetts species was preoccupied by Ashmead (Proc. Wash. Acad. Sci. Vol. IV, p. 193) for an Alaska species.

A number of specimens of this species, taken at Twinning, Maryland, were seen to vary from the typical form in that the whole body was of a ferruginous color with the exception of the apical half of the abdomen which was piceous black.

***Pezomachus aciculatus* nom. nov.*****Pezomachus foersteri* Brues.**

The specific name "foersteri" proposed by Brues (Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 67) for a Texan species was preoccupied by Bridgeman (Trans. Ent. Soc. London, p. 343) for a British species.

***Pezomachus ferruginosus* nom. nov.*****Pezomachus insolens* Brues.**

The specific name "insolens" proposed by Brues (Bull. Wis. Nat. Hist. Soc., Vol. VIII, No. 2, p. 67) for a Washington species was preoccupied by Förster (Arch. f. Naturg. Vol. XVI, p. 130) for a Central European Species.

***Pezomachus cressonii* nom. nov.*****Pezomachus gracilis* Cress.**

The specific name "gracilis" proposed by Cresson (Can. Ent. Vol. 4, p. 63) for a Pennsylvania species was preoccupied by Förster (Arch. f. Naturg. Vol. XVI, p. 209) for a Central European Species.

***Pezomachus insularis* nom. nov.*****Theriscopis rufipes* Ashm.**

The St. Paul Island, Alaska species described as *Theriscopis rufipes* by Ashmead (Wash. Acad. Sci. Vol. IV, p. 191 1902) is wingless in both sexes and has not a true scutellum in the ♀. It must therefore be transferred to *Pezomachus* where the specific name "rufipes" is preoccupied by Bridgeman (Trans. Ent. Soc. Lond., p. 157. 1883) for a British species.

***Pezomachus americanus* Ashm.**

***Theroscopus americanus* Ashm.**

This Virginian species described as *Theroscopus americanus* Ashmead (Trans. Amer. Ent. Soc. Vol. 23, p. 211) also belongs to the genus *Pezomachus*.

***Pezomachus kukakensis* Ashm.**

***Theroscopus kukakensis* Ashm.**

This species, described by Ashmead with the preceding, from Kakak Bay must also be transferred to *Pezomachus*.

***Micromeson* nov. Sub-genus of *Pezomachus*.**

Head large, wider than the thorax, but not very transverse. Antennæ of ♀ not very slender, longer and more slender in the ♂. Thorax sub-cylindrical. Prothorax greatly enlarged and swollen, larger than the much reduced mesothorax, the mesonotum of which only covers the median area of the basal half of the anterior thoracic node. Scutellum defined as a small indistinct tubercle in the ♀, but more definite in the ♂.

"Metathorax" strongly gibbous with no carina. Females apterous. Male apterous in only known species.

Petiole very long and unusually slender, somewhat longer than the "metathorax," with or without prominent spiracles. Ovipositor shorter than the petiole.

There are three species belonging to this group:

*Pezomachus texanus* (Cress.) Can. Ent. Vol. 4, p. 64.

" *annulatus* (sp. nov.)

" *lymensis* (sp. nov.)

They fall into a class so distinct from the other named *Pezomachi* that they certainly deserve a separate subgeneric if not a new generic name.

The most conspicuous characters are:

1. The much reduced mesonotum, and correspondingly swollen prothorax.
2. The elongated, slender petiole, associated with the uncarinated "metathorax"

***Micromeson annulatum* sp. nov.**

Female 6-6.5 mm. A large conspicuous species with head and thorax entirely clear ferruginous. The abdomen is of a somewhat darker ferruginous color and has a very conspicuous black basal band on the third segment, and a less distinct one on the second segment. Remaining segments with very narrow inconspicuous apical bands.

Head from above shagreened, dull, not quite twice as wide and thick along the median line. Anterior, or facial, border rather concave and sunken between the eyes. The margined occiput is but slightly excavated. Antennæ 23-25 jointed, concolorous with the head, though rather more



dusky apically; rather longer than head and thorax together, not slender. Seventh and neighboring flagellar joints about twice as long as wide. Clypeus transverse with deep fovea on either side. Malar lines indistinct, cheeks rather swollen, closely and evenly punctured. Mandibles bifid with dark teeth. Palpi rufous and rather long.

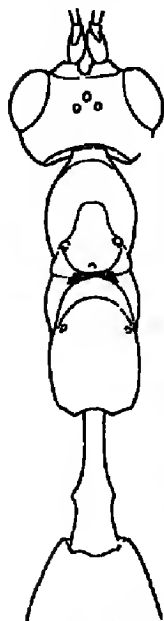


Fig. 5.  
*Micromeson*  
*annulatum*.

Thoracic nodes sub-equal, shining though finely punctured. The pro- and meso-thorax about the same length medially. Separated by a rather indistinct suture. Prothorax rather sharply constricted anteriorly to form a well defined neck. Mesothorax quite flat in front of scutellar suture. Scutellum indicated by an obsolete tubercle. "Metathorax" strongly gibbous, with no indication of a carina. Legs clear ferruginous, somewhat more dusky than the thorax.

Abdominal petiole as long as the "metathorax", only slightly expanded at the apex, with rather prominent spiracles; concolorous with ground color of remaining segments. Closely and evenly shagreened. Remainder of abdomen oblong oval  $2\frac{1}{2}$  times as wide as the thorax, ferruginous, closely and evenly shagreened, and with a very sparse minute pubescence; second segment with an indefinite piceous basal band, third segment with a very conspicuous broad black basal band. Third and following segments with narrow black apical bands varying much in intensity.

Ovipositor somewhat shorter than the petiole. Sheaths dusky at the base and black at the apex.

**Observations.** Described from 8 specimens taken at Twining, Maryland, in March and April. This is evidently closely related to *M. lymense* sp. nov. but is readily distinguished by the absence of median furrows on the meso- and "meta"-thorax.

Type in the National Museum.

Paratype in the Bussey Institution, Harvard University.

#### *Micromeson lymense* sp. nov.

Female 6-6.5 mm. A large conspicuous species, with head and thorax entirely fuscous. Abdomen fuscous with a conspicuous black base band on the third segment, and a less well defined similar band on the second segment. Mesothorax and "metathorax" medially sulcate.

Head from above shagreened, dull, with a very sparse pubescence; not quite as broad as thick along the median line. Anterior, or facial, border straight, level with the eyes, margined occiput but little excavated. Antennae about 24-jointed, concolorous with the head, rather longer than the head and thorax together. Seventh and neighboring flagellar segments about twice as long as broad. Clypeus transverse

with a deep fovea on either side. Malar lines indistinct, cheeks rather full, closely and evenly punctured. Mandibles bifid with dark tips. Palpi fuscous with apical joint piceous.

Thoracic nodes sub-equal, rather coarsely punctulate; prothorax restricted anteriorly to form a neck, but not very markedly so. Mesothorax rather shorter than the prothorax, from which it is separated by a well defined suture. Scutellum indicated by a small tubercle. "Metathorax" strongly gibbous, with no indication of a carina but with a median shallow suture on anterior half. Legs rather more piceous than thorax.

Abdominal petiole as long as the metathorax, only slightly expanded toward the apex, but with rather prominent spiracles, evenly shagreened and very sparsely pubescent. Remainder of abdomen oblong oval,  $2\frac{1}{2}$  times as wide as the thorax, dark fuscous, closely and evenly punctured, and with a short very sparse pubescence. Second segment with an indefinite piceous basal band. Third segment with a conspicuous broad black basal band. Remaining segments unbanded. Ovipositor somewhat shorter than the petiole, sheaths light at the base, black at the apex.

*Observations.* Described from a single specimen hatched from a Drassid Egg Cocoon on May 7, 1911. Collected by A. B. Champlain, Lyme, Ct., April 30, 1911.

This is evidently closely related to *M. annulatum* sp. nov. from which it can be readily distinguished by its darker color and sulcate thoracic nodes.

#### NORTH AMERICAN SPECIES OF THE GENUS THAUMATOTYPUS, FÖRSTER.

<i>alaskensis</i> Ashm.	♀	<i>Cremnoides alaskensis</i> Ashm. Trans. Am. Ent. Soc. Vol. 23, p. 211.	ALASKA.
<i>canadensis</i> Harrington	♀	<i>Cremnoides canadensis</i> , Harrington. Can. Ent. Vol. 24, p. 213.	QUEEN CHARLOTTE ID.
<i>spinulatus</i> sp. nov.	♀		CONNECTICUT.
<i>tuberculatus</i> Ashm.	♀	<i>Cremnoides tuberculatus</i> Ashm. Trans. Am. Ent. Soc. Vol. 23, p. 211.	CALIFORNIA.

#### NORTH AMERICAN SPECIES OF THE GENUS PEZOLOCHUS, GRAV.

<i>bucculatrix</i> Ashm.	♀	Proc. Nat. Mus. Vol. 12, p. 421.	WASHINGTON, D. C.
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#### NORTH AMERICAN SPECIES OF THE GENUS PEZOMACHUS, GRAV.

<i>scutellatus</i> nom. nov.	♀	<i>P. foersteri</i> Brues. Bull. Wts. Nat. Hist. Soc. Vol. VIII, No. 2, p. 66.	TEXAS.
<i>alternatus</i> Cross.	♀	Can. Ent. Vol. 4, p. 64.	ILLINOIS.
<i>alaskensis</i> Ashm.	♀	Proc. U. S. Nat. Mus. Vol. 12, p. 421.	ALASKA.
<i>americanus</i> Ashm.	♂	<i>Theracopis americanus</i> Ashm. Trans. Am. Ent. Soc. Vol. 23, p. 211.	VIRGINIA.
<i>angularis</i> Brues	♀	Trans. Am. Ent. Soc. Vol. 29, p. 119.	TEXAS.
<i>ashmeadii</i> nom. nov.	♀	<i>Cremnoides californicus</i> Ashm. Proc. U. S. Nat. Mus. Vol. 12, p. 420.	CAL., COLO., UTAH.
<i>auripes</i> sp. nov.	♂		ALASKA.
<i>berkmani</i> Brues	♀	Trans. Am. Ent. Soc. Vol. 29, p. 119.	TEXAS.

<i>brunell</i> nom. nov.	♀	<i>P. obscur</i> Brues. Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 71.	MASS., PA., CONN., N.
<i>brevisstylus</i> sp. nov.	♀		PENNSYLVANIA.
<i>californicus</i> Ashm.	♀	Proc. U. S. Nat. Mus. Vol. 12, p. 421.	CALIFORNIA.
<i>canadensis</i> Cress.	♀	Can. Ent. Vol. 4, p. 62.	ONTARIO.
<i>cockerelli</i> Brues	♀	Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 62.	FLORIDANT.
<i>coloradensis</i> sp. nov.	♀		COLORADO.
<i>compactus</i> Cress.	♀	Can. Ent. Vol. 4, p. 62.	ILLINOIS.
<i>crassulus</i> Brues	♀	Trans. Am. Ent. Soc. Vol. 29, p. 119.	TEXAS.
<i>crassus</i> nom. nov.	♀	<i>P. gracilis</i> Cress. Can. Ent. Vol. 4, p. 61.	PENNSYLVANIA.
<i>delumbis</i> Brues	♀	Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 75.	WASHINGTON.
<i>dingar</i> sp. nov.	♂ ♀		MARYLAND.
<i>ferrugineus</i> nom. nov.	♀	<i>P. insular</i> Brues. Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 74.	WASH., CAL.
<i>flavistralis</i> Brues	♂	Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 67.	NEW JERSEY.
<i>flavocinctus</i> Ashm.	♂ ♀	Proc. U. S. Nat. Mus. Vol. 12, p. 421.	TEXAS, CONN., MD., N. Y.
<i>foveatus</i> Brues	♀	Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 67.	MASSACHUSETTS.
<i>gentilis</i> Cress.	♂ ♀	Can. Ent. Vol. 4, p. 61.	PENNSYLVANIA.
<i>habilis</i> Brues	♀	Bull. Wis. Nat. Hist. Soc. Vol. VIII, No. 2, p. 67.	MASSACHUSETTS.
<i>insellus</i> Howard	♂	Bull. Dept. Agric. Wash. Sec. Ent. Vol. 5, p. 33.	COLUMBIA.
<i>insularis</i> nom. nov.	♂ ♀	<i>Theroscopus rufipes</i> Ashm. Wash. Acad. Sci. Vol. 4, p. 191.	ST. PAUL ISLAND, ALASKA.
<i>keenii</i> Harrington	♀	Can. Ent. Vol. 26, p. 214.	CANADA.
<i>kukukensis</i> Ashm.	♀	<i>Theroscopus kukukensis</i> Ashm. Wash. Acad. Sci. Vol. 4, p. 191.	KYKAY BAY, ALASKA.
<i>longipes</i> sp. nov.	♀		CALIFORNIA.
<i>longistylus</i> sp. nov.	♀		
<i>macr</i> Cress.	♂	Can. Ent. Vol. 4, p. 64.	PENNSYLVANIA.
<i>maculatus</i> sp. nov.	♀		CALIFORNIA.
<i>maculicollis</i> Brues	♀	Trans. Am. Ent. Soc. Vol. 29, p. 119.	MASSACHUSETTS.
<i>manni</i> sp. nov.	♂		CALIFORNIA.
<i>mesobilis</i> Cress.	♀	Can. Ent. Vol. 4, p. 61.	ILLINOIS.
<i>micraris</i> Harrington	♂ ♀	Proc. Ent. Soc. Wash. Vol. 2, p. 294.	BOR. AMER. PENN.
<i>minimus</i> Walsh	♂ ♀	Ira. Injur. Ill. p. 43.	ILLINOIS.
<i>minutus</i> sp. nov.	♀		ALASKA.
<i>niger</i> Prov.	♀	Addit. Faun. Can. Hymen. p. 362.	CANADA.
<i>nigrellus</i> Ashm.	♂ ♀	Proc. Wash. Acad. Sci. Vol. 4, p. 192.	PRIB. ISLAND, ALASKA.
<i>nigrofuscus</i> sp. nov.	♀		PENNSYLVANIA.
<i>nodosus</i> sp. nov.	♀		KANSAS.
<i>obscurus</i> Cress.	♀	Can. Ent. Vol. 4, p. 62.	N. J., MASS.
<i>ottawaensis</i> Harrington	♂ ♀	Can. Ent. Vol. 25, p. 77.	PENN., CONN.
<i>obscur</i> Ashm.	♀	Proc. Wash. Acad. Sci. Vol. 4, p. 192.	ALASKA.
<i>pennsylvanicus</i> sp. nov.	♀		PENNSYLVANIA.
<i>petitii</i> Cress.	♀	Can. Ent. Vol. 4, p. 61.	ONTARIO, MASS.
<i>robustus</i> sp. nov.	♀		ARIZONA.
<i>similis</i> sp. nov.	♂ ♀		MARYLAND.
<i>spiraculus</i> sp. nov.	♀		NORTH CAROLINA.
<i>sulcatus</i> Prov.	♀	Addit. Faun. Can. Hymen. p. 77.	CANADA.
<i>stanfordensis</i> sp. nov.	♀		CALIFORNIA.
<i>tanillius</i> Cress.	♀	Can. Ent. Vol. 4, p. 62.	ILLINOIS.
<i>thripites</i> Tay.	♀	Am. Agric. N. Y. (1860) p. 300.	NEW YORK.
<i>unicolor</i> Cress.	♀	Can. Ent. Vol. 4, p. 64.	MASS., DEL., ILL., MO
<i>urbanus</i> Brues	♀	Bull. Wis. Nat. Hist. Soc. Vol. 8, No. 2, p. 67.	NEW YORK, CONN.
<i>utahensis</i> sp. nov.	♀		UTAH.
<i>wheeleri</i> Brues	♀	Trans. Am. Ent. Soc. Vol. 29, p. 119.	ILLINOIS.

## SUB GENUS MICROMESON.

<i>annulatum</i> sp. nov.	♀		MARYLAND.
<i>lymense</i> sp. nov.	♀		CONNECTICUT.
<i>texanum</i> Cress.	♂ ♀	<i>P. texanus</i> Can. Ent. Vol. 4, p. 64.	TEXAS.

## NEW NORTH AMERICAN CHILOPODS AND DIPLOPODS.

By RALPH V. CHAMBERLIN,  
University of Pennsylvania, Philadelphia.

### CLASS CHILOPODA.

#### Family LITHOBIDÆ.

#### Genus *Arenobius* Chamberlin.

#### *Arenobius coloradanus* sp. nov.

Dorsum from testaceous to dark brown and dull chestnut with the posterior plates and the first one usually not all darkened. Head mostly the same color as dorsum or very nearly so, or somewhat more reddish. Antennæ concolorous with head, pale distad. Venter from yellow or testaceous to dark brown, the caudal plates usually a little darker. Prosternum and prehensorial feet of same color as head or nearly so. Legs of same color as adjacent portion of venter.

Head widest at level of marginal interruptions; clearly wider than long (11:10); caudal margin straight. Depressed or furrowed parallel with frontal suture a little cephalad of the latter, from this furrow a median longitudinal furrow extending toward anterior margin. Two, usually clearly impressed, longitudinal furrows on caudal region of head, one a little each side of the middle and the two united in front of the posterior margin by a transverse furrow. Smooth and shining.

Dorsal plates all very finely or obscurely roughened, appearing smooth and shining to the naked eye; usually no furrows distinctly developed excepting the usual depression or furrow immediately within the caudal and lateral margins and on some the short transverse mark on each side near margin at about one-third length of plate from caudal margin. Posterior angles of ninth, eleventh and thirteenth dorsal plates strongly produced; posterior angles of other minor plates rounded or obliquely excised.

Ventral plates all punctate and finely roughened; impressed with three longitudinal furrows of which the median is most distinct, the latter on some of the more posterior plates ending caudad in a deeper pit or depression about one-third the length of plate from caudal edge; mostly with a rather wide transverse depression or furrow caudad of middle of plate. Sometimes an additional longitudinal furrow showing on each side between the median and the lateral, the caudal end often curving mesad to unite with its mate at middle; this furrow often more or less united with the lateral one. The last several plates sometimes with furrows very obscure or practically absent.

Antennæ short or very short, reaching the sixth or seventh segment; articles 30 to 35, the second very long with those more distad much shorter, cylindric, subuniform or, more usually, with longer articles occurring singly at intervals among the shorter ones, in general decreasing in size distad. Hairs of medium length.

Eyes composed mostly of from 9 to 12 ocelli arranged in three series; e. g., 1 + 3, 3, 2, 1 + 4, 3, 3, 1 + 4, 4, 3,. The single ocellus much largest, subvertically elliptic or oval.

Prosternum about 1.6 times wider than long. Teeth 2+2, small acute. Median incision wide and moderately deep, its sides concave. Spine on each side well ectad of outer tooth, much more slender than teeth but stouter at base than neighboring hairs, bristle like distad.

Coxal pores circular, well separated; in number arranged as follows: 3, 4, 4, 3; 3, 4, 4, 4; 4, 5, 5, 5.

Coxae of anal legs armed laterally and dorsally; other coxae seemingly unarmed. Spines of first legs  $\frac{0, 0, 2, 1, 1}{0, 0, 1, 2, 1}$  or  $\frac{0, 0, 2, 1, 1}{0, 0, 1, 3, 1}$ ; of the second and third  $\frac{0, 0, 2, 2, 1}{0, 0, 2, 3, 1}$ ; of the fourth  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 1}$  or, occasionally,  $\frac{0, 0, 3, 2, 1}{0, 0, 2, 3, 1}$ ; of the fifth  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 1}$ ; of the sixth to the eleventh,  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$ ; of the twelfth and thirteenth,  $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$ ; of the penult,  $\frac{0, 0, 3, 2, 2}{0, 1, 3, 3, 2}$  in the female, or  $\frac{0, 0, 3, 2, 1}{0, 1, 3, 3, 2}$  in the adult male, each having claw armed with two accessory claws; of anal,  $\frac{1, 0, 3, 2, 1}{0, 1, 3, 3, 1}$ , the dorsal spine of tibia and also outer one of femur readily lost so that spining may appear thus,  $\frac{1, 0, 3, 2(1), 0}{0, 1, 3, 3, 1}$ , two accessory claws present as in the penult pair. In the female the anal legs are short and very slender, decreasing gradually in diameter from the femur distad, the tibia being intermediate in diameter between femur and first tarsal article as the latter is between tibia and second tarsal article; tibia rather weakly longitudinally furrowed along dorsal surface. Penult legs similar to anal except for smaller size. In the male the anal legs are also rather slender but the tibia is crassate, being fully as thick as the femur and being widest at distal end and abruptly thicker than the first tarsal joint, its dorsal surface shallowly depressed, a longitudinal dorsal furrow also present on femur and prefemur, that of the latter less distinct. Penult legs of male also slender, with joints dorsally longitudinally furrowed; the tibia obliquely excised at dorso-caudal corner of distal end and bearing at this place a small, flattened lobe or crest which is transverse to the axis of the joint, this lobe bearing a few short hairs but nothing like the brush in manegitus.

Gonopods of male relatively wide, flattened, truncate distad; bearing mostly 4-6 bristles in a transverse row along distal edge of ventral side.

Gonopods of female with claw entire, long and stout, acutely pointed, considerably curved, darkened distad. Basal spines 2 + 2, subequal or with the inner in some individuals considerably shorter. stout; in ventral view acutely conical in outline. Articles, especially the second and third, glabrous or nearly so on ventral and mesal surfaces, but clothed with a moderate number of bristles on ectal and dorsal surfaces.

Body rather slender being about 7.5 times as long as width of tenth plate; conspicuously attenuated cephalad from eighth plate, with the plate much narrower than the third. Width of head, first, third, and tenth dorsal plates to each other as 40, 33, 37, 47 and 47, the and tenth plates being equal and manifestly considerably wider than the head.

Length from 12 to 15 mm. A male 13 mm. has antennæ 5 mm. long anal legs exclusive of coxa, circa 4.8 or 5 mm. long, with the tenth about 1.7 mm. wide.

Locality: Manitou, Colorado (author, Aug., 1910).

***Arenobius sontus* sp. nov.**

Brown to deep mahogany. Head in some degree darker than dorsum. Antennæ chestnut, paler distad. Prosternum brown to mahogany, paler than head. Venter testaceous to deep brown, the caudal plates darkest. Legs testaceous to brown, the posterior pairs darker with their tarsi usually paler.

Head and first dorsal plate smooth and shining; other dorsal plates rugose, the more caudal ones more strongly roughened than the anterior ones.

Antennæ of moderate length, reaching the seventh segment. Composed of from 40 to 50 articles which beyond the first ones become short, often showing an alternation of a very short article with longer ones in groups between.

Eyes composed of mostly 9 to 12 ocelli arranged in three series; thus, 1+3, 4, 2.

Prosternal teeth 2+2, the two fused at base in a dental plate, the inner larger than the outer and both much stouter than the ectal spines which, nevertheless, is stout and tooth-like and not at all bristle-tipped.

Coxal pores circular decreasing markedly in size proximad, the most distal being large; in number and arrangement, 5, 5, 5, 4; 5, 5, 5, 5; 6, 6, 6, 5, etc. None of the posterior coxæ armed laterally. Spines of first legs,  $\frac{0, 0, 2, 1, 1}{0, 0, 1, 3, 2}$  or  $\frac{0, 0, 2, 1, 1}{0, 0, 1, 2, 2}$ ; of second  $\frac{0, 0, 2, 2, 1}{0, 0, 2, 3, 2}$ ; of third to sixth,  $\frac{0, 0, 2, 2, 2}{0, 0, 2, 3, 2}$ ; of seventh and eighth,  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$ ; of ninth and tenth,  $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$ ; of eleventh,  $\frac{1, 0, 3, 2, 2}{0, 0, 3, 3, 2}$ ; of twelfth,  $\frac{1, 0, 3, 2, 2}{0, 1, 3, 3, 2}$ ; of penult,  $\frac{1(2), 0, 3, 2, 2}{0, 1, 3, 3, 2}$ ; of anal,  $\frac{1(2), 0, 3, 2, 1}{0, 1, 3, 2, 1}$ , with two claws, the penult having three. As noted in the formulæ, the dorsal spine of the posterior coxæ is frequently replaced by two situated close together. The anal legs of the male slender, the tarsal joints especially slender; tibia bearing near distal end of its mesal surface toward dorsal side a small, flattened, subtriangular lobe or crest the long axis of which is parallel to that of the joint and its higher end caudad, its mesal or long edge somewhat convexly curving. Penult legs slender bearing no special lobes.

Gonopods of male rather large and broad, conspicuously exposed; distally rounded, bearing about ten or twelve long bristles.

Gonopods of female with claws very long and stout, moderately curved. First article excavated on mesal side toward base as usual; this side strongly chitinized as usual. Basal spines 2+2, large and stout, well separated, the outer larger than the inner on each side.

Gradually and considerably attenuated cephalad, the first plate narrowest as usual.

Length from 22 to 30 mm. A male 26 mm. long has antennae 1 mm. long and anal legs as 9.5 mm. long with its tenth plate as 3.1 mm. wide.

Locality: Mexico (Guadalajara and Tuxpan).

Genus *Guambius* gen. nov.

Type.—*Lithobius euthus* Chamberlin.

Other known species belonging to this genus are *pinguis* Bollman, *curtior* Chamberlin and *mississippiensis* sp. n. described below.

*Guambius mississippiensis* sp. nov.

Dorsum dilute chestnut, with the caudal plates and a median longitudinal line somewhat darker. Head and antennae dark chestnut, the latter paler distad. Venter testaceous, darker brown caudad. Prosternum and prehensorial feet nearly the same as head. Legs testaceous, the caudal pairs a little darker.

Head slightly wider than long (36: 35 or 34.5); widest at marginal interruptions, between which and the eyes the diameter is nearly uniform, the sides caudad of this convex and strongly converging; the median portion of caudal margin straight. Rather strongly transversely furrowed or depressed immediately in front of caudal marginal thickening, the furrow extending entirely across head and continuous with caudal ends of a wide longitudinal furrow extending cephalad dorsal of level of eyes on each side. A short transverse sulcus a little cephalad of and parallel with median part of frontal suture, a median longitudinal sulcus extending forward from this transverse one and showing or passing through a deeper pit-like impression at middle of length. Smooth and shining, or only very obscurely uneven.

Dorsal plates finely roughened. Major plates, excepting the seventh, showing distinctly the short transverse submarginal sulcus on each side about beginning of caudal third of plate, the seventh plate showing a similar sulcus near each caudal corner and one near each anterior corner as well. Most of the major plates marked with two distinct longitudinal sulci which diverge more or less from near the caudal margin cephalad, these sulci in some distinct only cephalad of the submarginal transverse marks. Posterior angles of eleventh and thirteenth plates a little produced, those of others rounded or obliquely excised.

Most ventral plates with a rather deep longitudinal furrow toward each side but mesad of a weaker submarginal furrow also present. The usual median longitudinal furrow with also the transverse depression cephalad of caudal margin also more or less evident.

antennae very short, reaching to or nearly to the sixth segment; segments 25, of which the second is longest, those immediately following abruptly shorter but only very gradually decreasing in size distad. There are about 11 to 14 in number, arranged in four series; thus, 1+5, 1 and 1+4, 3, 2, 1. The single ocellus much the largest, subcircularly elliptic or oval. Prothorax 1.5 times wider than long or slightly more. Teeth 2+2, equal, acute, with line of apices manifestly recurved. Median incisor rather wide and deep with its sides concave. Ectal spines much slender than the teeth, bristle-like distad, acute. Coxal pores circular, of moderate size; in number, in type specimen, 3, 1, 4, 3.

No spines of posterior coxae evident. Spines of first legs 0, 0, 1, 1, 1, 1, 0, 0, 1, 2, 1; of second, 0, 0, 1, 2, 1; of third, 0, 0, 1, 2, 1 or 0, 0, 1, 2, 2; of fifth and sixth, 0, 0, 1, 2, 2; of seventh, 0, 0, 1, 2, 2; eighth to tenth, 0, 0, 2, 2, 2; eleventh, 0, 0, 2, 2, 2 or 0, 0, 2, 2, 2; of twelfth, 0, 0, 3, 2, 2; of thirteenth, 0, 0, 3, 2, 2; of the penult, 0, 0, 3, 1(2), 0(1), 0, 1, 3, 3, 1, armed with two claws; of the anal 0, 0, 3, 2, 1, 0, 1, 3, 3, 1 claws in type broken off. The anal legs of male strongly crassate, the prefemur particularly elevated dorsally; femur conspicuously excavated dorsally, the excavation extending from end to end as a broad and rather deep furrow; the tibia much less swollen than the femur, complanate or shallowly furrowed longitudinally on dorsal surface; hairs short and straight, more numerous on dorsal surface of all joint but nowhere dense or forming bunches; articles not laterally furrowed. Penult legs crassate in about same degree as the anal but the tibia relatively larger; distal end of tibia obliquely excised at dorso-caudal corner and bearing there a triangular plate or keel-like lobe which lies longitudinally with the elevated end caudad; prefemur, femur and tibia longitudinally furrowed above, but the furrow of femur scarcely more developed than that of the other articles and this article not otherwise especially modified; none of articles bearing bunches of hair, the latter being everywhere sparse; tarsal joints abruptly more slender.

Gonopods of male wide, truncate distad, flattened in an ecto-ventral dorso-mesal direction; bearing a few short bristles in a row along distal edge of ventral side.

Body strongly narrowed from eighth plate forward to the first which is clearly narrower than the third; the eighth and tenth plates of equal width and much wider than the head, the latter in type being even slightly narrower than the third plate. Body about  $7\frac{1}{4}$  times longer than width of tenth plate.

Length of type (a male) 12.5 mm.; of antennae 5 mm.; width of tenth plate 1.7 mm. Width of head, first, third, eighth, and tenth plates to each other about as 18, 17, 19, 24 and 24.



Locality: Byram, Mississippi (author, July, 1910).

In ANNALS ENT. SOC. AMERICA, 1911, p. 43 the type of the species was referred tentatively to *A. aedipes* Bollman, but study of the type of the latter shows it to be clearly distinct.

Genus *Gosibius* Chamberlin.

*Gosibius monicus* sp. nov.

Dorsum brown, with a darker median longitudinal stripe which shows a marked tendency to spread laterally at the caudal end of each plate and often reaches the lateral margins across the caudal border. Head ferruginous; the median longitudinal stripe of dorsum continuing forward upon the head as far as a little caudad of the frontal suture where it ends abruptly at a pale transverse band. Antennæ ferruginous. Prosternum and prehensorial feet pale ferruginous. Venter yellow or testaceous, the caudal segments darker, more reddish or ferruginous. Legs yellow or testaceous like the venter, nearly uniform, or the caudal pairs slightly darker dorsally.

Head subcordate, wider than long in about ratio 47:45. Caudal margin mesally gently incurved; sides conspicuously converging from the lateral interruptions caudad about the rounded corners. A median longitudinal sulcus extending forward from frontal suture to a transverse depression between the antennæ, narrow and not very deep. A short, deep, transverse sulcus a little in front of median portion of caudal margin, the same being more weakly indicated farther laterad on each side. Smooth and shining, not punctate or roughened.

First dorsal plate smooth and shining like the head, or very obscurely roughened. Other dorsal plates more or less roughened, the more caudal ones most strongly so. Major plates with the short transverse sulcus adjacent to each lateral margin at about one-third its length from caudal end, the seventh having in addition a similar sulcus near the middle of length. A median longitudinal furrow on each side between middle and lateral margin which may be indistinct, especially on caudal portion of plate; this furrow at about beginning of middle third of length sending off a more clearly impressed branch directly mesad which may be united with the corresponding furrow from the other side; often a short sulcus running from near anterior margin obliquely ecto-caudad toward point of origin of this transverse furrow.

Ventral plates apparently smooth and shining; the usual three longitudinal impressions indicated in varying degrees of distinctness. On several of the caudal plates the median furrow may end caudad in a deeper, pit-like and somewhat transverse, depression a little in front of caudal margin of plate.

Antennæ long. In types tips are broken off so that full number of articles can not be ascertained; but the number present indicates that the full number is somewhere above 29.

Eyes in types from 15 to 17 in number, arranged in four series; thus, 1+4 (5), 4, 4, 2; 1+4, 4, 4 (3), 4.

Posterior teeth 2+2, stout, conical, much closer together than in *L. paucidentis* and also larger, but the proportion of anterior margin occupied by the teeth is larger than in that species. Ectal spines long and distally drawn out to slender, bristle-like, acute tip; the tubercles contiguous with the teeth and not well removed from it as in *paucidentis*. Anal pores circular, rather small; 4, 3, 3, 3, in the types. First four pairs of coxae laterally armed. Spines of first legs, 2, 1; of second, 0, 0, 3, 2, 1; of the third and fourth, 0, 0, 3, 2, 2; of the fifth to ninth, 0, 0, 3, 2, 2; of the tenth, 1(0), 3, 2, 2; of the eleventh, 0, 0, 3, 3, 3; of the twelfth and thirteenth, 1, 0, 3, 2, 2; of the penult, 0, 1, 3, 3, 3; of the anal, 1, 0, 3, 2, 2(1?). Anal legs in the female short and moderately slender, the dorsal surface of femur and tibia distinctly longitudinally furrowed, the same articles of penult legs similarly but less strongly furrowed.

Gonopods of female with the claw long and acute, strongly curved and chitinized. Proximal article excavated at base on mesal side, leaving a conspicuous lobe at distal end which projects mesad and meets the corresponding lobe of other gonopod; the caudal and mesal sides of this articles strongly chitinized as usual. Basal spines 2+2, stout, the inner smaller than the outer. Median process of sternite first clavately widening caudad, and then attenuated to a slender acute point.

Length of types 14 to 15 mm. A specimen (female) 14 mm. long has anal legs 5.8 mm. long and the tenth dorsal plate 2 mm. wide, the body being thus seven times as long as the width of this plate. The body moderately narrowed cephalad and the first plate slightly narrower than the third whereas it is wider in *paucidentis*. The widths of head and first, third, eighth and tenth dorsal plates to each other about as 33, 47, 48, 57, and 57.

Locality: Santa Monica, California (author, June, 1909).

#### Genus *Lithobius* Leach.

##### *Lithobius devorans* sp. nov.

Dorsum from brown to chestnut and, in largest individuals in full color, almost mahogany. In lighter individuals the head is chestnut and clearly darker than the dorsal plates excepting the first in some in which it may approach the same color; in the more deeply colored individuals the head is deep chestnut or mahogany of scarcely deeper shade than that of dorsal plates. Antennae chestnut, usually paler at very tips only. Prosternum chestnut, the prehensorial feet more rufous. Venter fulvous to brown, the caudal plates always darker and either reddish or very deep brown. Legs colored like contiguous portion of venter, the caudal pairs being thus always darker.

Head slightly wider than long (72: 70). Caudal margin straight or nearly so; posterior corners conspicuously and widely rounded, the

sides immediately in front of them but little excurved, diverging forward to the lateral interruptions which are distinct. The short curved transverse submarginal sulcus opposite interruption of each side evident. The usual semi-circular impression on caudal portion clearly marked. There is also present a transverse sulcus immediately caudal of and subparallel with frontal suture, the sulcus being most distinct at the sides. Surface sparsely punctate and moderately uneven.

Posterior dorsal plates conspicuously roughened; the anterior ones less strongly so and the first uneven only in about same degree as the second. The short transverse sulci most distinctly impressed on the more caudal plates, mostly weak on the anterior ones. Caudal plates with short hairs more numerous than on the anterior. Posterior angles of the seventh, ninth, eleventh and thirteenth dorsal plates strongly produced; processes of ninth, eleventh and thirteenth long and acute, those of the seventh obtusely rounded, the inner or mesal edges being convex and long with its apical or distal portion nearly transverse.

Anal segment in the male densely clothed above with rather long hairs, most of which are curved or uncinatate at tips, this being a very characteristic feature of the species. In the female the dorsal hairs of this segment are sparse and straight.

The three longitudinal sulci of ventral plates distinct, being on most broadly and deeply impressed to a little in front of caudal margin. Last plate more densely clothed with short hairs. Sternite of genital segment also densely clothed with hairs especially in the male.

Antennae reaching the beginning of the eighth segment; attenuated, very slender distally. Composed of mostly from 32 to 35 articles which, distad of the first few, are rather short, considerably shorter ones occurring at intervals among longer ones as in related species.

Eyes composed of from 28 to 42, but mostly from 30 to 36, ocelli which are arranged in from 5 to 8 series; e. g., 1+3, 4, 6, 6, 6, 5; 1+3, 4, 6, 6, 6, 6, 3; 1+6, 5, 6, 5, 4, 4, 4; 1+6 5, 6, 5, 5. Single ocellus moderately large, oval. All seriate ocelli deeply pigmented excepting those of first row which are commonly paler as in related species. Of seriate ocelli the caudal ones of first row are clearly the largest.

Prosternum about 1.7 times wider than long. Distance between chitinous spots 1.8 times the width at level of bottom of mesal incision, and 2.5 to 2.7 times as great as length of dental line, the variation depending on number of teeth. Teeth 5+5 or 6+6, or occasionally 5+6; distally narrowly rounded. The prosternal spine situated immediately ectad of outer tooth as usual, slender and bristle like, and curved as in voracior.

In larger specimens the coxal pores are very large and strongly transverse, while in the smaller adults the form may approach that of the pseudomaturus stage, being transversely elliptic and with those at ends of rows often subcircular. In number and arrangement from 6, 6, 6, 5 to 8, 8, 8, 7, other arrangement noted being 6, 7, 7, 6, to 7, 7, 7, 5, and 7, 8, 8, 6.

at three pairs of coxae laterally armed. Spines of first legs, 2, 1; of the second,  $\frac{0, 0, 3, 2, 1}{0, 0, 2, 3, 2}$ ; of the third,  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$  or  $\frac{0, 0, 3, 2, 2}{0, 0, 3, 2, 2}$ ; fourth and fifth,  $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$  or  $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$ ; of the sixth to the eighth,  $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$ ; of the twelfth,  $\frac{1, 0, 3, 2, 2}{0, 1, 3, 3, 2}$  the thirteenth being the same; of the penult,  $\frac{1, 0, 3, 1, 0}{0, 1, 3, 3, 2}$  or  $\frac{1, 0, 3, 2, 1}{0, 1, 3, 3, 2}$  the anterior or ectal dorsal spine of the fourth joint in the latter case being mostly very small, etc. two or three, in latter case the anterior accessory being very small; of anal,  $\frac{1, 0, 3, 1, 0}{0, 1, 3, 3, 2}$  the claw single.

The anal legs in the male are short. Fourth article considerably thickened, more so than in voracior; dorsal or dorso-mesal surface conspicuously bowed ventrad or depressed over middle and posterior portion, or the depression often almost strictly mesal, longitudinally furrowed along depressed surface; also longitudinally furrowed along dorsal surface toward ectal edge of latter. Third and fourth articles rather deeply sulcate longitudinally on ventral surface. Tibia longitudinally furrowed dorsally. Tarsal joints not clearly sulcate mesally. Penult legs very similar to anal but the fourth article but slightly enlarged and not at all excavated meso- or caudo-dorsally, though the dorsal longitudinal furrow is conspicuous.

The single article composing the gonopod of male well exposed; directed caudo-ectad; sides nearly parallel; distally subtruncate; bearing mostly about four bristles. In the gonopods of the female the claw is comparatively short; strongly bent; tripartite, the three lobes distinct, the median being considerably larger much as in vorax but not so greatly exceeding the lateral as in mordax, etc. Basal spines stout and moderately long; mostly uniformly attenuated from base to apex. Mesal side of first article straight, diverging cephalad from mesal side of fellow but little.

Body appearing to vary considerably in relative width, the length being mostly as much as eight times longer than width of tenth plate, but in some falling a little below this (7.75) and in others as much as 8.4 times longer. Moderately attenuated cephalad from eighth plate, with the first plate a very little wider than the third and usually a little narrower than the head, occasionally as wide as latter; the average ratio of widths of head, first and tenth plates is 30:29:35. In one male the widths of head and first, third, eighth, tenth and twelfth dorsal plates stand to each other as 72, 72, 70, 78, 78, and 72.

Length from 18 to 26 mm. A male 25 mm. long has antennae about 12.5 mm. long, anal legs 8.5-9 mm. long and the tenth dorsal plate 2.9 mm. wide.

Locality: Jackson, Alabama (author, 1910).

This species is very close to the next, *L. voracior*. Usually both sexes of fully grown specimens of these species are to be distinguished quite readily by the form of the coxal pores

these in voracior being circular or broadly elliptic whereas in devorans they are larger and mostly strongly transverse. In some cases, however, it is difficult to separate the females, although the males are always very readily distinguished by the character of the hair clothing the anal segment dorsally, this in devorans being long and dense with nearly all the hairs uncinatè distally whereas they are all straight in the other species. Devorans averages larger. It is relatively more slender and the width of the head as compared with that of the tenth plate is as 60:70 on an average whereas the average corresponding ratio in voracior is 60:65.5

*Lithobius voracior* sp. nov.

Dorsum brown, the first plate and the several most caudal ones commonly darker and more reddish of chestnut; plates often showing three longitudinal pale lines. Head conspicuously darker than the dorsum, cherry red or chestnut, or in others often very dark, nearly mahogany. Antennæ chestnut, much lighter distad. Prosternum dark brown or dilute brownish chestnut, with the prehensors paler. Venter yellowish brown, the posterior plates much darker, burnt brown. Legs yellowish brown, the posterior pairs darker, being often somewhat chestnut with distal articles a little paler.

Head wider than long. Widest immediately back of eyes. Sides rather strongly convex and converging caudad of the well marked marginal breaks to the rounded posterior corners. Caudal margin nearly straight or but slightly incurved mesally. The usual subcircular impression on caudal portion. Surface subsparsely punctate, the punctæ varying in size but mostly fine; obscurely uneven.

First dorsal plate with surface similar to that of head. All finely punctate. Plates roughened more especially the caudal ones as usual, the elevations or irregular tubercles small. Posterior angles of seventh, ninth, eleventh and thirteenth dorsal plates strongly produced, processes of the seventh much as in devorans.

Anal segment in male dorsally densely clothed with rather long and strictly straight hairs, these not being at all distally curved or uncinatè. In the female the dorsal hairs of this segment are but sparse.

Ventral plates densely punctate and with numerous fine impressed lines which mostly run out from the punctæ. The usual longitudinal furrows clearly developed. Hairs of posterior plates more numerous and longer.

Antennæ of moderate length, reaching mostly to the end of the seventh or beginning of eighth segment. Attenuated considerably but the distal portion not very fine. Articles beyond the first several rather short. Hairs moderately long. Articles in number from 32 to 36.

Eyes composed mostly of from 30 to 35 ocelli, rarely as few as 23, arranged in from 5 to 7 longitudinal series; e. g., 1+3, 5, 5, 5, 4; 1+3, 1, 5, 6, 5, 4, 2; 1+3, 5, 6, 6, 4, 3; 1+3, 5, 6, 6, 6, 1, 3; 1+4, 6, 7, 6, 5, 4, 1.

ocellus large subvertically oval. Ocelli of most dorsal row and paler as in related species. Prosternum 1.6 times wider than long. Distance between chitinous 1.9 times wider than long of prosternum at level of bottom of incision; 2.3 or 2.4 times as great as length of dental line usually, varying with number of teeth present. Prosternal teeth 6+6 to other numbers noted being 6+7, 7+7, and 7+8; either uniform or varying irregularly in size; subacute, being but narrowly rounded at tip. Spine proximally clearly stouter than the hairs, but distally bristle-like, curved; situated immediately ectad of outer tooth. Coxal pores transversely elliptic or in part subcircular; of medium size; in largest specimens more strongly transverse as in the preceding species. In number from 6, 6, 6, 4 to 8, 8, 8, 6, other arrangements frequently noted being 6, 7, 7, 5; 6, 7, 6, 5; 6, 6, 6, 5; 7, 7, 7, 6, and 7, 8, 8, 7.

Last three pairs of coxae laterally armed. Spines of first legs,  $0, 0, 3, 2, 1$ ; of second,  $0, 0, 3, 2, 1$ ; of third,  $0, 0, 3, 2, 2$ ; of fourth to eighth,  $0, 0, 2, 3, 2$ ; of ninth to eleventh,  $0, 0, 3, 2, 2$ ; of twelfth,  $0, 0, 2, 3, 2$  or  $0, 0, 3, 3, 2$ ; of thirteenth,  $1, 0, 3, 2, 2$ ; of penult,  $1, 0, 3, 1, 1$  or  $1, 0, 3, 2, 1$ ; of anal,  $1, 0, 3, 1, 0$  or  $0, 1, 3, 3, 1$ , the anterior spines of fourth joint in latter case being mostly very small, tarsi ending in three claws but the anterior accessory one mostly minute as in related species; of anal claw single.

Anal legs in female short and rather slender; the third, fourth and fifth articles longitudinally sulcate dorsally, the fourth being most deeply so; the third and fourth articles sulcate ventrally. Penult legs similarly but less strongly sulcate. In the male the penult legs are as in the female; but the anal legs are more strongly modified. Fourth article with dorsal surface depressed or bowed ventrad over middle and proximal portion; relatively thicker than in female; articles longitudinally sulcate along mesal surface, especially so in the more distal ones.

Gonopods of male rather small; distally strongly rounded or broadly subconic; bearing 6 or 7 long bristles.

Gonopods of female with claw long and rather strongly bent or curved near middle; tripartite, the median division long and acute, the lateral small and also usually acute, the inner or more dorsal one considerably more distal in position than the outer one which is near the middle of length of claw. Basal spines long and stout, subequal, attenuated uniformly from base distad. Basal article with inner side nearly straight.

Body more robust than in devorans, the length being mostly less than seven times as great as width of tenth dorsal plate (6.S). Considerably attenuated cephalad from eighth plate, with the third plate narrower

than the first and the latter clearly narrower than the head. Average ratio between widths of head and first and tenth dorsal plates 68:65:7.3. A male has widths of head and first, third, eighth, tenth and twelfth dorsal plates to each other as 68, 65, 63, 75, 75, and 68.

Length from 17 to 24 mm. A female 19 mm. long has antennae 10.5-11 mm. long, anal legs 8.5+ mm. long, and tenth dorsal plate 2.8 mm. wide. Males have similar relative measurements.

Type Locality: Fernwood, Mississippi.

Known Localities: Mississippi (Fernwood, Canton and Byram. Author, collector, 1910).

Although it has seemed impossible on the basis of any previously stated characters to maintain as distinct several species allied to *L. mordax* and *L. vorax*, through the use of characters not previously detected the writer finds it now an easy matter to discriminate between them. Such of this group of species, the larger forms dominating in the Southeast, as have the posterior angles of seventh, ninth, eleventh and thirteenth dorsal plates produced thus far known from the U. S., are, in addition to *devorans* and *voracior*, above described, the following: *mordax* K., *transmarium* K., *vorax* Meinert, *tyrannus* Bollman, *suprenans* Chamberlin, and *latzeli* Meinert. The writer's previously expressed opinion that *clarus* McNeill was based upon immature specimens has been confirmed by an examination of the types of this species, these proving to be *vorax* in the pseudomaturus stage; *mordax* and *transmarinus*, merged by Bollman in *spinipes* Say, are clearly distinct; and study of types shows *tyrannus* and *latzeli* to differ from *vorax* which previously had been thought identical, the published diagnoses revealing no truly distinctive characters.

#### Genus *Sozibius* gen. nov.

Type.—*Lithobius tuobukus* Chamberlin.

The following species is placed here only tentatively.

#### *Sozibius pungonius* sp. nov.

Dorsum very light brown. Head cephalad of frontal suture and the caudal segments darker, somewhat orange colored. Antennae yellow. Venter and legs very pale, the posterior pairs bright yellow. Prosternum and ultimate ventral plates dark yellow.

Antennae short composed of twenty-one articles of which the first six are long, the others shorter.

Ocelli about eleven, small arranged in three curved and rather irregular series; thus, 1+5, 3, 2.

Prosternal teeth 2+3.

Angles of none of the dorsal plates produced.

coxal pores very small, 2, 3, 3, 2.

Ultimate pair of coxæ armed laterally, the ultimate and penult armed dorsally.

Spines of first legs 2, 3, 2; of the penult 1, 3, 3, 2, the claw single; of ultimate 1, 3, 2, 1, the claw single.

Anal legs of male long and slender the fourth, fifth and sixth joints longitudinally furrowed on ectal surface, laterally compressed.

Length.

Locality: Marshall, Colorado (Prof. T. D. A. Cockerell).

One male specimen.

**Genus *Poabius* gen nov.**

*Type*.—*Poabius verdescens* Chamberlin.

Other known species belonging to this genus are *bilabiatulus* Wood, *pitrophilus* Chamberlin, *sokovus* Chamberlin, *clavigerens* Chamberlin, *utahensis* Chamberlin, *yukus* sp. n., and the two new species described below.

***Poabius nankus* sp. nov.**

Light orange brown, caudal borders of major scuta darker; head somewhat darker caudad of frontal suture. Antennæ and legs yellow. Venter yellow, the prosternum and caudal segments a little darker.

Body markedly attenuated from tenth dorsal plate cephalad. Most dorsal plates with a strong median furrow which may be doubled and, on each side, one or two approximate lateral ones diverging from it caudad; within each lateral margin a furrow or sulcus running from near anterior edge at first near to and subparallel with the lateral margin and then bending away from it caudo-mesad to end at the transverse furrow which traverses most plates a little cephalad of caudal margin.

Head subcordiform; caudal margin nearly straight; distinctly margined caudally and along cauda-lateral angles; a short transverse sulcus a little cephalad of caudal margin and between this and the frontal suture a median and several lateral pairs of longitudinal impressed lines or sulci.

Antennæ moderately short, composed of twenty more or less uniform articles.

Ocelli pale, small, fifteen or sixteen in number arranged in four straight and regular series; thus, 1+5, 4, 4, 1 (2).

Prosternal teeth dark, low, 2+2.

Angles of none of the dorsal plates produced.

Coxal pores circular, the edges weakly chitinized; 2, 3, 3, 2.

Last two pairs of coxæ laterally armed; the last three pairs dorsally armed.

Spines of the first legs 1, 3, 2; of the penult, 1, 3, 3, 2, armed with three claws; of the anal 1, 3, 2, 1, the claw single.

Gonopods of female with the claw tripartite; basal spines 2+2.

In the male the anal legs have the prefemur elevated into a rim-like structure on dorsal or dorso-mesal side at distal end, and the femur bears at the proximal end on same side an ear-shaped process which is



excavated above, the depression being continuous with a longitudinal median furrow on dorsal surface. See Pl. XII, fig. 4.

Length 13-14 mm.; width at tenth plate 1.9-2.2 mm.

Locality: Las Valles, New Mexico (Prof. T. D. A. Cockerell).

The types consist of a male and a female.

***Poabius igneus* sp. nov.**

Light brown, scuta mostly with the caudal borders darker, reddish brown; posterior segments darker. Head chestnut, darkest behind frontal suture, a dusky or blackish median longitudinal stripe for a short distance in front of caudal margin. Legs yellowish, caudal pair from base to fourth joint inclusive reddish brown or chestnut, distally like the others. Venter brown, the ultimate plates reddish brown. Prosternum light reddish brown. Antennae mostly dark brown, becoming pale distad.

Scuta roughened, mostly showing a median and two lateral longitudinal sulci or in some the median replaced by two diverging sulci.

Antennae moderate, articles 20.

Ocelli distinct, ten in number, arranged in three series; thus, 1+4, 3, 2.

Prosternal teeth 2+2.

Angles of none of the dorsal plates produced.

Coxal pores small, well separated, round, 2, 3, 3 (4), 2.

Last two pairs of coxae laterally armed.

Tarsi of anterior pairs of legs rather indistinctly biarticulate. Spines of first legs 2, 3, 2; of penult 1, 3, 3, 2, armed with three claws; of the anal 1, 3, 2, 0, the claw single.

Gonopods of female with the claw tripartite; basal spines 2+2, proximally clavate, distally conical.

Anal legs of male with the fourth joint enlarged and bearing meso-dorsally and proximad of middle a conspicuous, flattened, keel-like lobe and at its distal end a small wart-like elevation.

See Pl. XIII, fig. 2.

Length 11.5 mm.; width 1.7 mm. Length of antennae 4 mm.; of anal legs 4.2 mm.

Locality: Madison, Wash. (Dr. E. Bergroth).

Closely allied to *P. bilabiatus* and *P. verdescens*; but manifestly smaller and differing in the lobes of anal legs and in the smaller number of spines borne dorsally at distal end of third joint, etc. See Pl. XIII, figs. 1 and 2.

Family CRYPTOPIDÆ.

Genus **Kethops**, gen. nov.

Pairs of legs 23.

Seventh segment not bearing spiracles.

First dorsal plate with transverse semi-circular sulcus.

Other dorsal plates excepting the ultimate with two sharply impressed longitudinal and subparallel sulci.

last dorsal plate margined laterally, caudal margin convexly ending.  
 ventral plates elongate, narrowed caudad the caudo lateral corners acutely excised. (See Pl. XIII, fig. 5). Each with a distinct longitudinal median sulcus and submarginal sulci.  
 pseudopleura produced caudad into an acutely pointed process; ventrally; armed ventrally and laterally with spines.  
 legs sparsely armed with spinose bristles which appear spinose especially on proximal joints. A stout spine at distal end of tibia in position and a second one ventral. Tarsi, excepting the plate, one-jointed, a stout ventral spine distad of middle.  
 femur of anal legs armed with rows of spines on mesal and ectal side and on most of the ventral. Femur similarly armed mesally and ventrally. The tibia with similar spines ventrally. Tarsus composed of but two joints and ending in a distinct and very stout claw.

Type: *Kethops utahensis* Chamberlin.

The type species was originally described from Utah under the genus *Newportia*, the absence of anal legs from the type specimen leading to the reference to this genus. While close to *Newportia*, it has various *Cryptops*-like characters and is readily separated by the character of the anal legs, etc. A short time ago among some old material from New Mexico sent me by Prof. Cockerell, a perfect specimen of the form was found, making possible the diagnosis given above. A description of this specimen follows:

***Kethops utahensis* Chamberlin.**

Ferruginous, uniform; antennae and legs, excepting the ultimate pair, paler, yellowish; anal legs colored like the body, but pale distad.

Head coarsely punctate, two diverging longitudinal sulci on the caudal portion which begin at a transverse sulcus in front of and parallel the caudal margin.

Antennae composed of seventeen articles.

First dorsal plate with semi-circular impression deep, somewhat angularly bent caudad at middle, mesal portion in a broad depression or pit on the caudal slope of which there is a distinct W-shaped mark like that found in many species of *Newportia*, the two usual longitudinal sulci over caudal portion of plate.

Sulci of second plate strongly diverging caudad, those of the succeeding plates nearly parallel.

Last dorsal plate without distinct sulci; caudal margin convexly bowed out; lateral margins armed with two rows of spinules. (See Pl. XIII, fig. 3).

Anterior margin of prosternum straight or nearly so, but slightly indented mesally. Prosternum punctate, two sulci, which, approximate below, diverge distad toward the free margin.

Ventral plates irregularly punctate, more densely so on caudal portion. Median sulcus beginning a little caudad of anterior margin and extending over anterior two-thirds or somewhat more of length of plate; a submarginal sulcus on each side which is deepest mesally; usually two or more weaker and more indefinite transverse sulci as shown in the figure. (See Pl. XIII, fig. 5).

Last ventral plate narrowed caudad; rounded caudadly; bearing spinules over entire surface.

Last pleurae furrowed laterally; with numerous small pores on ventral surface, both the free portion and that covered by ventral plate. Caudal process bearing acute spine distad. Pleurae with many spinules laterally and ventrally. (See Pl. XIII, fig. 4).

Femur of anal legs longitudinally furrowed both ventrally and dorsally; armed with numerous spines arranged in obliquely longitudinal rows which cover entire surface excepting dorsal portion and the furrow on the ventral. Femur also longitudinally furrowed dorsally and ventrally, the mesal side of ventral furrow formed by a keel-like elevation which does not quite reach distal end. Spines on edge of keel and elsewhere on ventral surface as shown in figure. Tibia with a mesally bent longitudinal keel, the bent mesal portion lower than end parts, this keel limiting a broad groove mesally, into which groove the tarsi of the specimen are bent or flexed like the blade of a knife. First joint of tarsus with at least one ventral spine; claw long and stout.

Length about 20 mm.

Locality: Glorieta, New Mexico (Prof. T. D. A. Cockerell).

The original type was collected by the author at the Warm Springs north of Salt Lake City in 1908.

Family SCOLOPENDRIDÆ.

Genus *Scolopendra* Linn.

*Scolopendra mohavea* sp. nov.

Very pale olive brown; the caudal half of body darker brown, dusky, or in one specimen largely solid black, with a pale longitudinal median line. Head paler cephalad of frontal suture.

Head with a transverse sulcus a little ways in front of the caudal margin, and between this sulcus and the caudal margin two straight, short, longitudinal sulci which are parallel. Cephalad of transverse caudal sulcus a pair of furrows which converge forward and end caudad of frontal suture, each furrow doubly curved, at caudal portion with concavity ectad, anteriorly convex ectad, the very anterior end bent abruptly mesad; ectad of each one of these furrows a second less sharply impressed furrow which also converges toward the mesal line cephalad; between the two sulci on each side a short sulcus runs obliquely cephalo-ectad. Smooth.

Antennae long; composed of twenty-six articles of which the first six or seven are comparatively smooth, the scattered hairs upon them increasing on number from the first article distad.

First dorsal plate with sharply impressed cervical furrow. On each side a furrow which caudad is parallel with caudal margin, from there angling obliquely cephalo-ectal. A median longitudinal sulcus cephalad with a cervical groove. Smooth.

Second dorsal plate with median longitudinal sulcus on anterior half. Two usual paired sulci crossing the entire plate and diverging caudad. On each caudo-lateral portion of plate a furrow curving obliquely cephalo-ectad as on first plate, similarly taking its origin near caudal margin.

Third and fourth dorsal scuta with median furrow. The paired longitudinal sulci less strongly diverging caudad than on preceding plates. Furrow on each caudo-lateral portion as in the preceding scuta.

On the fifth and subsequent dorsal plates the paired sulci become nearly parallel, but diverging some at the ends. Median furrow evident, but not so the caudo-lateral ones. On each side a longitudinal furrow subparallel with the lateral margin, this furrow often broken. On a few of the more caudal segments a transverse sulcus on each side parallel with and close to the anterior margin. The twentieth plate laterally margined for its entire length; the nineteenth all but a short distance caudad; the eighteenth not margined for a somewhat greater distance caudad and a short distance cephalad; the margination of the seventeenth and sixteenth plates similar to eighteenth but extending less caudad and cephalad reaching the transverse sulcus; other plates not margined.

Last dorsal plate with caudal margin mesally strongly and evenly convexly extended. A sharply impressed longitudinal median sulcus which does not quite reach the caudal margin. A short furrow parallel to the median one opposite its middle portion on each side.

Prosternum smooth; a median sulcus evident only for a short distance distad; transverse sulcus obscure; two weak longitudinal furrows, which, close to the mesal line caudad, diverge and are more distinct cephalad. Each dental plate with four teeth, of which the three inner ones are basally fused, the two most mesal being free only at their distal points; a deep narrow incision between the plates; the transverse furrow at base of each plate distinct, the two meeting mesally at an obtuse angle.

Basal tooth of prehensorial feet long, subacute, presenting but one point.

Penult article of palpus of second maxilla with a slender spine at distal end.

Ventral plates from the second to the twentieth inclusive with two sharply impressed longitudinal sulci which cross the entire plate.

Last ventral plate narrowed caudad, the sides weakly excurved; caudo-lateral corners rounded; caudal margin a little incurved mesally. Smooth. Depressed along the median line. A weak furrow subparallel with and not far from each lateral margin.

Prefemora and femora of legs of the first to penult pair inclusive without any dorsal spines at distal end; all with a tarsal spine, those of the first pair with two.

Pseudopleura ending in a stout process which terminates in two points or spines and bears proximad on its ectal surface a row of three stout teeth or spines.

Prefemur of anal legs ventrally with seventeen spines arranged in three longitudinal rows, of which the innermost is proximally irregular; these from ectal row mesad arranged thus, 4, 6, 7. Mesal surface with ten spines. Distal process with five spines. Femur unspined. Claws of tarsus with two basal spines.

Length 40-45 mm.

Locality: Fort Mohave, Arizona (March 7 and 18, 1911).

Three specimens received from Prof. Junius Henderson of the University of Colorado Museum.

Family SONIPHILIDÆ.

Genus *Soniphilus* Chamberlin.

*Soniphilus geronimo* sp. nov.

Yellowish brown anteriorly, becoming clearer yellow caudad. Head darker caudad of frontal suture. Antennæ light brown, paler distad. Legs yellow, those of anterior segments darker. Prosternum and prehensorial feet light reddish.

Antennæ of moderate length; articles moderate, not much differing in length, the ultimate about equal in length to the two preceding taken together.

Cephalic plate longer than wide in about ratio 7:6; narrowed cephalad; lateral and anterior margins convex, the latter a little emarginate mesally; middle portion of caudal margin sub-straight, rounded laterally. A short impressed median line back frontal region; on each side a little mesad from and parallel with margin a longitudinal furrow; on lateral portion of plate on each side a pair of sulci diverging cephalad and a second less distinct pair more mesal in position. Frontal plate not discrete. (See Pl. XII, fig. 4.)

Labrum with median piece comparatively large, bearing about six stout teeth.

Prebasal plate not exposed. Basal plate short, its greatest width more than 4.5 times the median length, a greater length exposed on each side. (See Pl. XII, fig. 4.)

Claws of prehensorial feet when closed not reaching anterior margin of head by a considerable distance. None of the joints bearing teeth or nodules. (See Pl. XII, fig. 2.)

Dorsal scuta with lateral sulci distinct; a second pair of sulci close to median line and on most also an intermediate sulcus on each side.

Anterior prescuta very short, increasing in length to about beginning of caudal third, then again more rapidly decreasing and becoming again short.

Anterior spiracle moderately large, circular or subcircular, being slightly vertically elongate; succeeding spiracles all circular, very gradually decreasing in size to the caudal ones which are very small.

First pair of legs much shorter and more slender than the second.

Ultimate legs long, the penult and antepenult joints furrowed longitudinally on ventral surface. Claw long and stout.

Sterna with a distinct median longitudinal sulcus or furrow which is ended at middle by a transverse furrow. Pores not detected.

Last ventral plate very wide, strongly narrowed caudad. Caudal fin straight or a little incurved. (See Pl. XII, fig. 3).

Anal pleurae bearing a number of small pores which are all wholly covered by the last ventral plate.

Anal pores not detected.

Pairs of legs 73.

Length 34 mm.; width 1 mm.

Locality: San Geronimo, New Mexico, (Mrs. W. P. Cockerell and Miss Mary Cooper, coll.).

#### CLASS DIPLOPODA.

##### Family NANNOLENIIDÆ.

##### Genus *Buwatia* gen. nov.

Ocelli none.

Antennae clavate, the fifth and sixth articles thickest; third and fifth longest, nearly equal in length, the second and fourth next.

Body decidedly narrowed caudad of head to sixth segment.

Body iulus-like in form. Segments without carinae, nearly smooth, not clothed with hair. All segments striate beneath; a deep sulcus across segment at level of pore.

Claws of legs long and slender.

Type: *Buwatia monterea* sp. nov.

As but one specimen of the type species has been secured, dissection for fuller structural details has not as yet been attempted. The genus may be distinguished from *Nannolene* through the absence of ocelli.

##### *Buwatia monterea* sp. nov.

Dorsum brown; head and anterior part of first segment whitish brown; first and ultimate segments light brown; a series of small, largely obscure dark spots along each side, one at each pore. Legs and antennae pale.

Body slender, nearly uniform in width for most of length but decidedly constricted from head and first segment to region of sixth segment.

Head nearly smooth, weakly and very finely punctate; glabrous except for a few bristles on clypeal and labral region. A weak median longitudinal sulcus across vertex. A furrow or excavation from base of each antenna caudad to lower margin of first dorsal plate, the antenna bent back and lying in this furrow.

Antennae rather short, strongly clavate; the seventh article short, its four sensory cones almost concealed in the terminal pit; clothing of hair becoming more and more dense distad, sparse proximad.

First dorsal plate large, closely embracing caudal portion of head. Anterior and posterior lateral angles rounded, the lateral margin between them extending obliquely caud-oventrad, rather, long, somewhat incurved. Anterior margin incurved at middle curving out convex on each side and then again at sides incurved bow-shaped. A transverse sulcus subparallel to the anterior margin and some distance from it and a second one submedian in position.

Subsequent segments with a longitudinal furrow at level of posterior, this more distinct on cephalic portion of segment. A transverse sulcus in front of median suture. Prozonites striate throughout, the posterior segment strongly striate beneath and on sides below level of posterior. Dorsum a little depressed; a weak longitudinal depression each side of middle, leaving mesal portion a little elevated.

Anal scutum considerably exceeded by the anal valves; caudal division short, widely and evenly rounded, set off or limited from major portion in front by a transverse sulcus. Caudal margin with two pairs of long setae.

Anal valves elongate, their free margins elevated. Each valve bears near its mesal margin a long seta at caudal and second one near middle of length in a furrow or sulcus which curves from mesal margin first laterad and then latero-cephalad.

Anal scale very short; caudally weakly convex, anteriorly strongly so; antero-lateral angles rounded, but not so the caudo-lateral ones.

Legs moderately long and slender; claws long, not robust.

Segments of body forty-five.

Length 11-12 mm.; width as .5-.5 mm.

Locality: Pacific Grove, Cal. (April, 1911, author.)

One specimen secured under a stone in an open field near the Hopkins Laboratory.

#### Family CAMBALIDÆ.

##### Genus *Titsona* gen. nov.

Eyes well developed, each consisting of a number of ocelli arranged in a single series parallel with anterior margin of the first dorsal plate.

Antennae short, very slender proximad but strongly enlarged distad, clavate; the fifth and sixth articles conspicuously and abruptly thicker than others. The third, fifth and sixth articles longest, not much differing in length from each other; second and fourth articles subequal.

Gnathochilarium nearly as in *Paiteya*. Promentum triangular, completely separating the laminæ linguales which are attenuated proximad to an acute angle. Mentum large, widening proximad.

Body strongly constricted from head and first segment to region of fifth and sixth segments, from where it again increases in width caudad.

First dorsal plate very large, extending over caudal portion of head from which the lateral portions extend free.

All segments striate beneath. Each segment from the fifth to the eighth inclusive with four carinae, a dorsal carina each side of median and one farther laterad on each side, the latter bearing the pore. Legs sparsely armed with spinescent bristles. First pair in male reduced, composed of six articles normally armed.

*Type:* *Titsona sima* sp. nov.

Evidently close to *Paiteya*, the type of which is likewise a Californian species.

*Titsona sima* sp. nov.

General color caudad of fifth segment dark brown, the caudal portion of each segment light brown. First dorsal plate light brown, a dark stripe parallel with but a little removed from the caudal and the cephalic border, the two stripes confluent at the sides of plate. Second to fourth segments light brown, each with a narrow transverse stripe of dark brown and especially laterally with a network of lines of same color, the proportion of dark larger the more caudal the segment. Head light brown, darker adjacent to first dorsal plate; on clypeus a square with upper side missing outlined in dark brown and immediately above this a subelliptical outline in same color with dorsal and ventral ends acutely angular. A pair of somewhat confluent brown spots in line from the brown about each eye ventro-mesad toward lower part of elliptical outline of front. Legs very pale.

Ocelli in a single row, 5-7 in number, black, uniform; the series parallel with margin of first dorsal plate which partly covers it on caudal side.

Antennae short, strongly clavate; the fifth and sixth joints much stouter than the others, the fifth strongly enlarged from its base distad, the sixth more uniform and broadest proximad. Hairs more dense distad as usual. (See Pl. X, fig. 5).

Stipites of gnathochilarium inclusive of processes nearly four times as long as greatest width. Mentum abruptly narrowed at distal end, wider at base than the median length approximately in ratio of seven to six. A semi-circular impression on proximal portion deeply impressed, the concavity directed distad. Promentum narrowly triangular. Laminæ linguales narrowed to an acute angle proximally, about three times as long as greatest width.

First dorsal plate very large, embracing caudal portion of head mesally, its lateral wings separated from sides of head by a space into which the antennae may be bent back. Anterior margin widely weakly concave, laterally running obliquely caudo-ventrad. Caudal margin nearly evenly convexly rounded mesally, lateral portion of plate bent ventrad and somewhat caudad and then mesad beneath. Caudal portion of plate more constricted than the anterior. On each side above lateral angle are several striae extending from caudal margin cephalad.

Next three segments striate beneath. Fifth and subsequent segments with prozonites striate throughout, the main division of segment striate beneath and dorsad only about half way to pore-bearing swelling



or carina. Each segment from the fourth to the antepenult with one carina, one far dorsad on each side consisting of a hemispherical swelling chiefly on portion cephalad of suture and bearing the pore, the other close to the mesal line and also more thickened cephalad than caudad, low, rounded. All segments constricted dorsad and cephalad from transverse suture. (See Pl. X, fig. 6).

Anal scutum long, widely rounded caudadly; a rather weak median longitudinal sulcus on anterior portion; a bristle borne each side of median line near middle of length, and a second pair borne on caudal margin.

Anal valves long, about equalling the anal scutum; smooth; median lines elevated; bearing two pairs of bristles close to mesal margin, one anterior caudal and the other submedian in position.

Anal scale short and broad, transversely narrowly elliptical. A pair of bristles borne on caudal margin, one each side of mesal line.

Legs rather sparsely provided with short spinose bristles.

First legs of male reduced, six jointed.

Gonopods of male reduced and nearly wholly concealed.

Segments ad forty-two.

Length about 16 mm.; greatest width 1 mm.

Locality: Oroville, Cal. (April, 1911; author coll.).

Two specimens were secured.

#### Family NEMASOMIDÆ.

##### Genus *Nemasoma*.

##### *Nemasoma uta*, sp. nov.

Dorsum dark brown, the color nearly solid in band on caudal portion of each segment and in some in a narrower stripe adjacent to anterior margin, the color over remaining portion of segment mostly in a network or areolation over a light background, the light spots often confluent dorsally into transverse band. Sides light brown, the light area extending farthest dorsad at middle of segment, the light area of sides limited on all sides by border of dark brown. Each segment with whitish spot on median dorsal line. Vertex of head areolated with lines of dark brown over a light background, the frons between bases of antennæ and the eyes dark brown, the area enclosing a pair of lighter spots each side of the median line and ventrad of these a second pair of spots between bases of antennæ at lower portion of the area. Clypeal region paler from presence of numerous lighter spots, ventrad and laterally yellow, as is also the lateral portion of head. Stipes of mandibles laterally covered with network of dark brown lines over light background. Eyes deep black. Antennæ brown, each segment whitish proximally and the second article almost wholly so. Legs brown, more or less broken with whitish, paler proximally. Ventral surface light brown. Anal scutum very dark, the anterior portion with numerous light dots. Anal valves pale along mesal border, elsewhere brown.

Body very slender, attenuated cephalad, narrowest immediately caudad of head.

head smooth, free from hairs except for the usual bristles along  
 1. A transverse sulcus between eyes, each side portion bending  
 2. to meet other at an obtuse angle on mesal line, to which angle  
 3. median longitudinal sulcus across vertex extends.

4. antennae longer than width of body; strongly clavate; sensory cones  
 5. Subdensely hirsute distally, more sparsely proximad.

6. eyes large, oblong, its upper and lower margins nearly parallel, the  
 7. mesal convex and the ectal oblique. Ocelli arranged in five series; thus,  
 8. 1, 4, 4, 2, giving a total of 17.

9. First dorsal plate narrower than the head inclusive of mandibles,  
 10. shorter than the two succeeding plates taken together. Middle portion  
 11. of anterior margin evenly convex, laterally extending obliquely caudo-  
 12. ventrad and somewhat concave. Caudal margin mesally straight, on  
 13. sides convexly bending cephalad and meeting anterior margin at an  
 14. angle. Dorsal of each lateral angles the plate is obliquely depressed or  
 15. shallowly furrowed.

16. Subsequent segments smooth above; striate ventrad of level of  
 17. pores, the lower or ventral striae deep.

18. Anal scutum in outline as viewed from above with lateral margins  
 19. parallel or a little diverging caudad, nearly straight or slightly convex;  
 20. caudal margin widely rounded, bearing beneath a seta on each side.  
 21. About equalling the anal valves or a little exceeded by the latter.

22. Anal valves strongly bulging from base to free mesal edge, the sur-  
 23. face of each valve extending very obliquely ventrad. A long bristle  
 24. borne near mesal edge of each valve near middle of length.

25. Anal scale with anterior and caudal margins each strongly convex,  
 26. the two meeting on each side in an acute angle. A pair of bristles  
 27. springing from mesal portion.

28. Number of segments 44.

29. Length 12.5 mm.; greatest width ad .75 mm.

30. Locality: Little Willow Canyon, Salt Lake County, Utah.  
 (1905; author, coll.).

31. But one specimen thus far found.

32. Family PARAIULIDÆ.

33. Genus *Paraiulus*.

34. *Paraiulus tivius* sp. nov.

35. Head light brown, a broad transverse band between eyes and ven-  
 36. trad of their level deep brown, the band enclosing above two pairs of  
 37. light dots, and between antennae a pair of large obliquely placed, oval  
 38. light spots, a bristle inserted in each of most dorsal pair of light spots;  
 39. vertex above the dark band with network of dark lines, a similar network  
 40. covering the stipes of mandibles laterally, each of the latter with dark  
 41. transverse stripe across dorsal part. Ventral surface and lower part  
 42. of sides of body light brown. On each side a series of black dots extend-  
 43. ing from sixth segment to about the antepenult. Anterior and caudal  
 44. margins pale, adjacent to the pale marginal stripe in each case a dark  
 45. transverse band which is much widest mesally; remaining part of plate

broken into network or areolation by light spots which may be confluent into one or more cross stripes. Other segments with the caudal transverse stripe, this becoming broader on more caudal segments and extending on each side to the lateral dark spot, below which it is continued as a more obscure band formed by network of dark lines. The dark band transversely divided by a series of light spots. Prozonites light brown. Anal scutum uniform dark brown, with anterior border pale. Legs light brown or yellowish. Antennae with proximal portion of each segment yellowish, the distal darker brown, especially in terminal articles.

A broad transverse depression extending between eyes, in its mesal portion or adjacent to same lying the setigerous light spots above mentioned. A median longitudinal sulcus crossing vertex and ending in the transverse furrow. Head nearly free from ordinary type hairs excepting the two setae mentioned and the bristles on clypeus and labrum. On lateral portions of clypeus and on the stipes of mandibles is a number of peculiar, probably sensory, hairs, each of which is sub-clavate in form with a narrow apical process and a slender basal stalk inserted in a corresponding pit, near the upper portion of which it presents a globose enlargement. (See Pl. XI, fig. 7). The tegument about the basal stalk dark.

Eyes triangular, an angle directed toward base of antennae, upper side straight, outer side convex above and concave below, mesal side concave above and convex below. Ocelli about 45 in 7 or 8 series; counting from above ventral, 8, 10, 8, 7, 5, 4, 2, 1.

Antennae rather short, conspicuously clavate.

First dorsal plate with lateral borders rounded anteriorly, not produced, angular posteriorly; margined anteriorly and laterally, the elevated anterior margin widest mesally, not margined caudally. One or two rather weak striae on each side below extending from caudal margin cephalad part way across plate.

Pores moderate, widely separated from the transverse suture which is straight or at most weakly sinuate at their level.

Anal scutum with caudal portion subtriangular as usual, the apical process bluntly rounded and not at all decurved; plate crossed by a series of transverse furrows or sulci of which the more caudal ones are deepest; caudal triangular portion of plate with a series of setae along each lateral margin, three similar long setae springing from caudal process. Lower portion of segment bearing a long seta near middle height of caudal margin and a second in line with legs of more anterior segments.

Anal valves nearly smooth, the mesal margins strongly elevated as usual; two setae on each valve just ectad of elevated mesal margin, one submedian and the second between this and the caudal end.

Anal scale with anterior margin convex, the posterior portion subtriangular its sides convex. A long seta borne on margin each side of mesal line. A dark line paralleling margin but indented mesally gives superficial appearance of caudal emargination to scale.

the gnathochilarium of the male has the promentum very large, elliptical in outline. For form and relations of stipes and other see Pl. XI, fig. 6.

First legs of male strongly enlarged, uncinatè, as usual; caudal glabrous excepting distal article, the anterior surface with long hairs. (See Pl. XI, fig. 5).

Second legs as usual greatly reduced excepting for the strongly reduced coxæ; the latter produced mesally into a long, tongue-like process which extends cephalo-ventrad between the first legs. (See Pl. XI, fig. 4).

Gonopods large and conspicuously exposed, bent above base strongly ventro-cephalad. Inner branch of anterior pair much longer than the outer, contiguous with each other mesally, clavately enlarged distad; outer branches broad, plate-like, densely clothed with long setæ along anterior-ventral and distal borders. Anterior pair apically terminating in two spines, the more anterior of which is a little curved distad and at end is expanded; the other process strongly curved ventro-ectad, crossing the first, and terminating acutely. (See Pl. XI, figs. 1 and 2).

Length ad 20 mm.; width 1.6 mm. (female). Male more slender, length 16-18 mm.; width 1.2 mm.

Locality: Mill Valley, Cal. (April 8, 1911; author, coll.).

About a dozen specimens were secured.

*Paraiulus timpius* sp. nov.

Dorsum with a broad band of light brown, paler than the sides. A median dorsal line of black which expands into a wider dot on anterior portion of each segment. Each segment bordered caudally with a narrow blackish stripe; a broader and more diffuse transverse dark band farther cephalad on segment, this band embracing a transverse row of four light spots of which the two inner ones are smallest, oblong and obliquely placed, sometimes confluent cephalad with anterior pale portion of segment, the two outer light spots confluent caudad with the pale area between the two dark bands. On the anterior segments the light and dark areas of dorsum merged and the whole covered with a close network or arcolation of dark lines over light ground and the median dorsal line as such less distinct. First dorsal plate entirely covered with similar network, the lower portion of sides dark brown or smoky; a narrow dark transverse stripe caudad of anterior margin. Sides of segments dusky or blackish, darkest along caudal margin, in a stripe continuous with the dark dorsal one, prozonites paler; a large light spot below level of pore on each segment, this spot mostly more or less constricted into two or three parts. Venter pale, a large light spot ectad of legs on each segment. Vertex of head with a dense network of black enclosing rows of very small, longitudinally oval light dots; frons between eyes solid black, enclosing a pair of light dots close to mesal line; brown between antennæ the area enclosing a number of paler dots. Clypeal and labral region yellowish. Antennæ deep purplish brown. Legs very pale, distal joints streaked with purplish or purplish brown.

Head finely roughened or rugose; free from hairs excepting the ones in clypeal and labral region and a single long median bristle at anterior end of the distinct median sulcus of vertex. A deep furrow extends from mesal angle of each eye to that of the other, the furrow angularly bent caudad mesally, the longitudinal median sulcus of vertex meeting this angle; farther forward a second transverse furrow, in front of which the head appears to bulge in a low transverse ridge.

Eyes large, triangular, its sides a little convex, one angle mesal and another immediately above base of antennae. Ocelli about 30, arranged in seven transverse and gently curving series; thus, 8, 8, 7, 6, 5, 3, 2.

Antennae moderate; proximal joints slender; distad thickened, clavate, as usual.

First dorsal plate large; mesal length about equalling that of two succeeding segments together. Anterior margin evenly convex; cephalo-lateral corners strongly rounded, the caudo-lateral more angular. Margined laterally and at sides cephalically, but not so the median portion; caudal border not margined. Not striate on sides below. A fine median longitudinal impressed line extending from caudal margin cephalad about three-fourths of the length of plate, at its anterior end breaking into two lines which diverge cephalad and become indistinct.

All subsequent segments striate beneath and over lower portion of sides, the striae deep.

Anal scutum rounded caudad, mesally weakly indentate, a slight tooth each side of indentation; smooth.

Anal valves smooth, the mesal margin but weakly and narrowly elevated.

Anal scale with caudal margin convex, the cephalic more strongly so, the two meeting at an angle on each side. A pair of caudally projecting bristles inserted a little in front of caudal edge.

Mandibular stipes considerably produced below, mesally excavated.

Gnathochilarium with the enlarged promentum narrowly elliptical or rather wider distad than proximad as shown in figure; relatively narrower than in most species. (See Pl. XI, fig. 8).

First legs of male strongly enlarged and uncinatè in the usual way; mesal surface complanate and strongly tuberculate, the tubercles in distinct cross series. Caudal surface glabrous, long hairs on the anterior.

Second legs with the greatly enlarged coxae fitting closely against bases of first legs and bent cephalad between the latter; other joints greatly reduced the ultimate densely clothed with short stiff hairs, those at apex longer.

Gonopods of male large and conspicuously exposed. Anterior pair with two main branches, the outer of which is flattened ect-mesally, of nearly uniform width, distally rounded, clothed with long bristles on mesal side; the inner branch also flattened or plate-like, bent cephalad and, as seen from ventro-caudal aspect, appearing expanded at free end into a foot-like shape with the toe mesal and the heel ectal in position. Each of the posterior gonopods enclosed or embraced at base on ectal side with a low plate the extended ends of which bend about it in front

hind; an inner process which is a narrow thin plate for most of its length terminating apically in a slender spine which curves cephalad part of hook; outer division consisting of a long slender style or which is bent apically and ends acutely, this lying against a twisted like division which at its end is sharply bent about the styliform in some distance below the end of the latter. (See Pl. XI, fig. 9). Number of segments 46.

Length about 18 mm.; width 1.8 mm. (male).

Locality: Las Valles, New Mexico, (Prof. T. D. A. Cockburn coll.).

A male and female are in the collection, the description above being that of the male.

***Parainulus garius* sp. nov.**

Head with brown band bordering labial and clypeal margins, the lower mesal portion of the clypeus being pale, its upper portion of same color as the border but not solid, the dark color a mottling or network over a paler background; a black transverse band between the two black eyes, this band concavely excised on front each side of middle and enclosing a pair of small light spots near median line; vertex of head covered with close network of black or deep brown color over a lighter background, a similar or somewhat paler network covering the stipes of mandibles laterally. Antennae dark purplish brown or blackish. Body dark or dusky brown the lower portions of sides and the venter paler; a continuous dark median longitudinal line along dorsum and a row of black dots along each side beginning at about sixth segment; a darker ring of more solid color about anterior portion of each segment; a sub-circular patch of closely placed light dots on lower portion of each segment, and between this patch and the black dot an elongate patch similarly formed, while dorsad of the black spot is a third area and between the latter and the mid-dorsal line an elongate narrow band or line of such light dots; caudad of the latter line and parallel with it is a light line or narrow band partly encircling the segment but fading out ventrad on each side, this light line being continuous, not broken into dots. First segment dark along both anterior and posterior borders. Anal scutum dark brown, the venter-caudal margins pale. Anal vales with cephalic portions dark brown, the meso-caudal portions light. Legs proximally clear yellow or light brown, the distal articles covered with network of dark purplish brown.

A deep transverse furrow between mesal angles of eyes, to which the median longitudinal sulcus across vertex extends. A row of setae along labral margin as usual and also a second row of about nine short setae across lower portion of clypeus, the latter row being inversely V-shaped with the angle very obtuse.

Antennae of moderate length, slender, not strongly clavate.

Lateral borders of first dorsal plate not produced; venter-caudal angle in outline sub-rectangular, the vertex rounded, the margin from here running obliquely cephalo-dorsad; anterior margin widely rounded,

the caudal nearly straight, both margined, more strongly so ventrad over lateral portions. Two deep longitudinal striæ across plate dorsad of lateral margin on each side.

Segments deeply striate beneath and on lower sides, the striæ on some anterior segments extending dorsad nearly to the black spot.

Repugnatorial pores moderate, well separated from the transverse suture which at this level is very weakly curved, remaining almost straight.

Anal scutum with apical process straight, acute, not at all decurved, somewhat exceeding the anal valves; bearing four setæ along each caudo-lateral margin. (See Pl. XII, figs. 6 and 7).

Anal valves with mesal margins elevated, the elevated ridge crossed by a series of transverse sulci; each valve widely depressed caudad of and not quite parallel with the margins of anal scale. Each valve bearing two setæ ectad of elevated mesal border, one at about one-third the distance from each end. (See Pl. XII, fig. 6).

Anal scale with caudal margin subsemi-circular, the lateral angles a little extended; anterior margin widely convex. A little cephalad of caudal margin two pairs of setæ borne on tubercles. (See Pl. XII, fig. 5).

Appendages of the second segment in female consisting of a plate presenting on each side a caudo-ventrally directed lobe which in lateral aspect appears clavate and is densely covered with bristles. Springing from the anterior portion of segment between the folds of plate is a pair of very small leg-like appendages distinctly jointed and terminating in a straight transparent claw; these appendages strongly suggestive of homology with the anterior pair of ordinarily ambulatory appendages of other segments. (See Pl. XII, fig. 8, a drawing from lateral and somewhat anterior direction of a specimen in which the first segment has been partly separated from the second the better to expose the parts; a leg of first segment is shown at left.)

Segments 52.

Length ad 31 mm.; width 2.2 mm. (female).

Locality: Tolland, Col. (Elevation, 8,000 ft.). Two female specimens collected by Prof. Cockerell in Aug., 1911.

#### Family POLYDESMIDÆ.

#### Genus *Polydesmus*

#### *Polydesmus bonikus* sp. nov.

Dorsum appearing dark brown from a close network of dark reddish brown lines over a ground of light brown; prozonites light brown; a black median dorsal line which is most distinct posteriorly. Head mostly light brown, mandibles and lateral portions palest, median portion covered with areolation of dark brown lines, a dark reddish brown band across region dorsad of level of antennæ, and extending ventral in tongue-like form between the latter. Antennæ light. Venter yellowish, with some parts tinged with pink. Legs yellow, commonly tinged with pinkish distad.

Body with sides almost parallel for most of length, attenuated anteriorly and the last few segments also attenuated in the usual way.

Vertex crossed by a deeply impressed sulcus which ends abruptly by a very short transverse line above dorsal margin of the dark transverse line. Head clothed with intermixed long and short setose hairs which are densest over frontal and clypeal region.

First dorsal plate a little wider than head inclusive of mandibles. Anterior margin weakly convex, meeting the lateral margin on each side at an obtusely rounded angle, the anterior and lateral margins rather roughly hemispherical; anterior and lateral borders transverse, distinctly margined. Each lateral margin obtusely incised at a point about one-third the distance from the caudo-lateral angle to the antero-lateral, but no teeth present. Caudal margin concave mesally and convex at each side, bow-shaped. Depressed longitudinally each side of median portion which appears elevated, more especially so caudad.

Second dorsal plate with lateral portions moderately bent cephalad touching or a little overlapped by the first plate. An acute tooth at antero-lateral angle; a little caudad of this a lower, very obtuse denticulation and half way between this and the caudal angle a third very weak or obscure denticulation. A broad longitudinal depression or furrow on each side somewhat less than half the distance from middle to lateral margin of plate. Tubercular areas very weakly developed, plate being nearly smooth.

Third plate very similar to the second but the lateral margins a little shorter. Caudo-lateral corner sub-rectangular, a little obtuse. Lateral teeth as on the second.

Fourth plate with lateral margin much longer than that of second and third plates. First and second denticulations smaller; antero-lateral angle well rounded.

Subsequent dorsal plates similar to the fourth. All with the lateral longitudinal depression as described for the second. Transverse sulcus weak. Distinctly margined caudally and laterally and along free portion anteriorly. The lateral denticulations very small; a fourth weak denticle appearing on some plates caudad of the third. Caudo-lateral angles becoming in posterior segments moderately produced caudad.

Anal scutum with process obtusely rounded and bearing long setae. Dorsally with conical setigerous tubercles.

Anal valves broad, rounded laterally and caudally. Margined mesally and also caudally and laterally, the lateral margin wide.

Anal scale roughly triangular, the anterior margin convex, the caudo-lateral sides very weakly convex, meeting at middle line in an acute angle.

Ventral plates with longitudinal and transverse sulci well developed.

Legs of moderate length; bristles densest distad; ultimate joint densest and subseriately setose ventrally.

First and second legs in male strongly reduced, the second pair a little larger than the first.

For structure of gonopods of male see Pl. X, fig. 3.

Length 19-20 mm.; width 2.2 mm.

Locality: Madison, Washington. (Dr. E. Bergroth).



## Family XYSTODESMIDÆ.

Genus *Xystocheir* Cook.*Xystocheir taibona* sp. nov.

Tegument thin, translucent, horn-brown in color, the carinae margins pale brick-red; prozonites paler; pigment about dorsal vesicles commonly showing through as a dark median line. Head very light or whitish shining brown, a triangular dark spot below each antenna formed of closely arranged small dots. Antennae light yellow or whitish. Legs pale yellow or yellowish brown, darker proximally. Venter and sides pale brown to yellowish.

A sharply impressed median sulcus crossing vertex and ending abruptly at about level of upper margins of antennal sockets or but little lower, crossing near its distal end a shallow furrow which arches across from the dorsal edge of one antennal socket to the other. Vertex smooth and shining. A few scattered bristles over frontal and clypeal region.

Antennae rather long, uniform; clothed with rather short hairs intermixed with long bristles, especially on proximal segments.

First dorsal plate a little wider than the head, shorter than the second. Cephalic and lateral margins together semi-circular. Caudal margin mesally straight or very slightly incurved, laterally extending obliquely cephalad. Entire border margined. Two pairs of impressed lines, the two on each side diverging from near the mesal line caudo-laterad, the anterior one nearly straight, the posterior curved, its convexity caudo-mesad.

Second plate and those immediately following with lateral portions bent cephalad, farther back the plates becoming first straight and then with the lateral portions bent more and more caudad. In the anterior plates the cephalo-lateral portion bulges cephalad, but in proceeding caudad the anterior margin first becomes straight and then the antero-lateral corners more and more strongly rounded caudad, the posterior corners becoming at the same time more and more strongly produced. All scuta distinctly margined. Each segment crossed by two transverse sulci of which the more caudal is deepest and longer.

Nineteenth segment very short, the lateral processes ordinarily exceeded by those of the eighteenth segment.

Anal scutum with process a little depressed, truncate distally where it bears several groups long bristles, crossed with two rugose lines a double one at posterior third and the other midway between this and the apex of process, each line bearing two pairs of double setae, two being inserted together in each case. In addition there is a marginal couple on each side of scutum farther cephalad.

Anal valves roughened; inner margins strongly elevated; each valve with two sulci extending from anterior margin caudad and somewhat laterad, the more mesal one with a double bristle inserted near its middle and each valve also bearing at its caudo-mesal angle a compact bunch of similar long setae.

Anal scale with anterior margin incurved mesally and convex laterally, bow-shaped; each caudo-lateral margin convex, meeting its neighbor of opposite side in a rounded obtuse angle. Scale crossed with a sulcus ending in the cephalo lateral corners and bending caudad across the plate; a weaker sulcus sub-parallel with this further cephalad; a third of the first or principal sulcus and extending to caudad margin there is on each side of middle a longitudinal sulcus. Just caudad of the longitudinal sulcus on each side and nearly upon the caudal margin is a single bristle.

In the gonopods of the male the two rami on each side are fused excepting distally, the ventral one not separate and opposed to the outer like a thumb as is the case in *T. dissecta* Wood. The principal or ventral ramus long and cylindrical, terminating in three spines which are inserted at the same level. Spines simply curved, not twisted; the ventral one flat, narrow, apically rounded; the outer one distally bent ecto-caudad, pointed; the dorsal one most slender. (See Pl. X, figs. 1 and 2).

Length ad 28 mm.; width 5 mm.

Locality: Region of Monterey Bay, Cal. (Pacific Grove, etc.)

A very common species in this locality (Author coll., 1902, 1909, 1911).

Related to *X. dissecta* (Wood) but the gonopods very distinct. *Nystocheir obtusa* Cook and *Fontaria furcifer* Karsch are doubtless synonyms of Wood's species. I have specimens of *dissecta* from near the type locality and find them to agree with Wood's description as well as with those of the two authors mentioned, when Woods' description is correctly apprehended. The nineteenth segment is somewhat variable in length, its distal processes occasionally extending considerably beyond those of the eighteenth, while in other cases the segment may be wholly covered by the eighteenth in which case the latter might be readily mistaken for the former.

## EXPLANATION OF PLATES.

## PLATE V.

*Xystocheir taibona* sp. nov.

Fig. 1. Gonopods of male, caudo-ventral aspect.

Fig. 2. The same, lateral aspect.

*Polydermus banikus* sp. nov.

Fig. 3. Left gonopod of male, caudo-ventral aspect.

*Titsona sima* gen. et. sp. nov.

Fig. 4. Left leg of first pair, caudal aspect.

Fig. 5. Antenna.

Fig. 6. Head and anterior segments, lateral aspect.

*Bucania monterea* gen. et sp. nov.

Fig. 7. Antenna.

## PLATE XI.

*Paraiulus livius* sp. nov.

Fig. 1. Gonopods of male, caudo-ventral aspect.

Fig. 2. Gonopods of male, lateral aspect.

Fig. 3. Third pair of legs of male.

Fig. 4. Second pair of legs of male, caudal aspect.

Fig. 5. First pair of legs of male, caudal aspect.

Fig. 6. Gnathochilarium of male.

Fig. 7. Sensory hair from lateral region of clypeus.

*Paraiulus timpius* sp. nov.

Fig. 8. Gnathochilarium of male.

Fig. 9. Gonopods of male, lateral aspect.

## PLATE XII.

*Soniphilus geronimo* sp. nov.

Fig. 1. Head, dorsal aspect.

Fig. 2. Head and prehensorial feet, ventral aspect.

Fig. 3. Caudal region of body, ventral aspect.

*Poabius nankus* sp. nov.

Fig. 4. Right anal leg, dorsal aspect.

*Paraiulus garius* sp. nov.

Fig. 5. Anal scale.

Fig. 6. Caudal end of body, lateral aspect, showing anal valves, scutum, etc.

Fig. 7. Same, dorsal view.

Fig. 8. Appendages of second segment of female as seen from lateral and slightly cephalic view. First segment partly separated from the second.

## PLATE XIII.

*Poabius verdescens* Chamberlin.

Fig. 1. Right anal leg, dorsal aspect.

*Poabius iginus* sp. nov.

Fig. 2. Right anal leg, dorsal aspect.

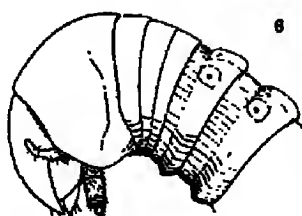
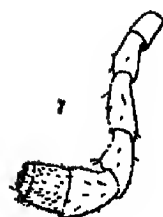
*Kelthops utahensis* Chamb., gen. nov.

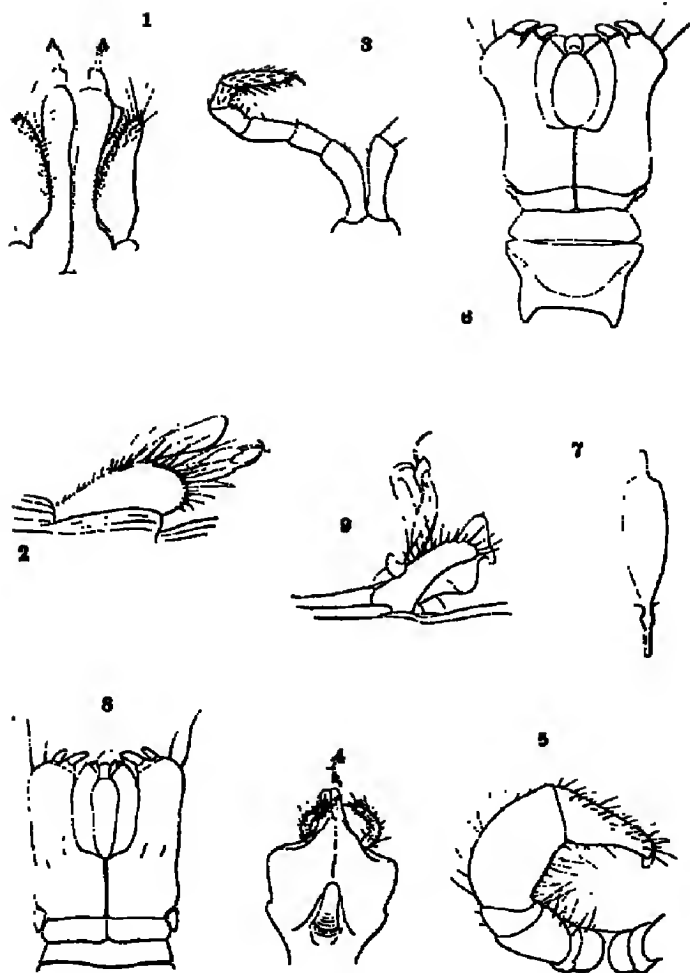
Fig. 3. Last two segments, dorsal aspect.

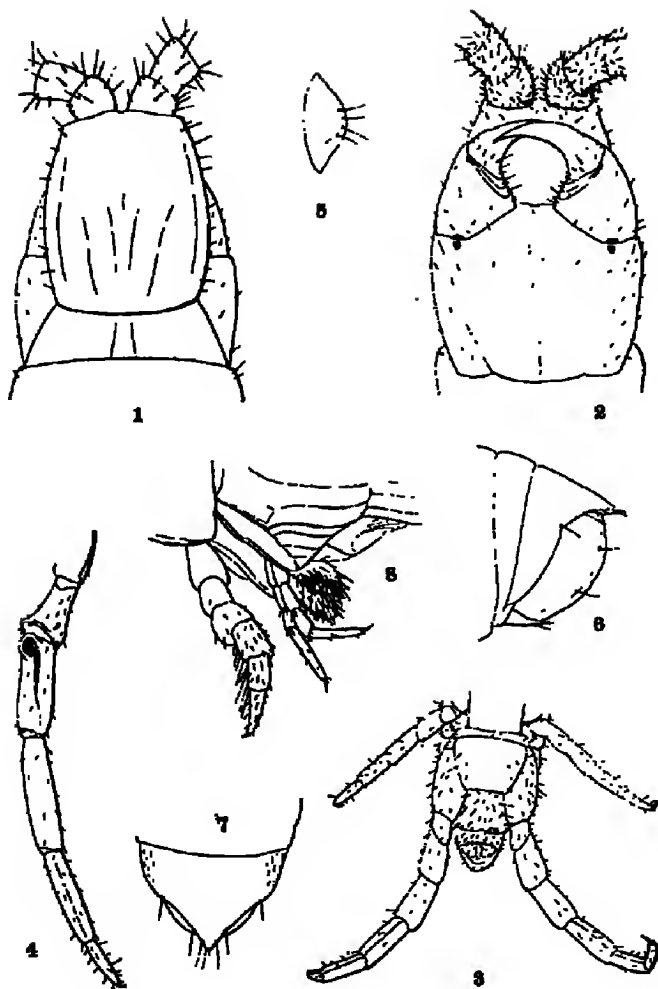
Fig. 4. Last segment, ventral aspect.

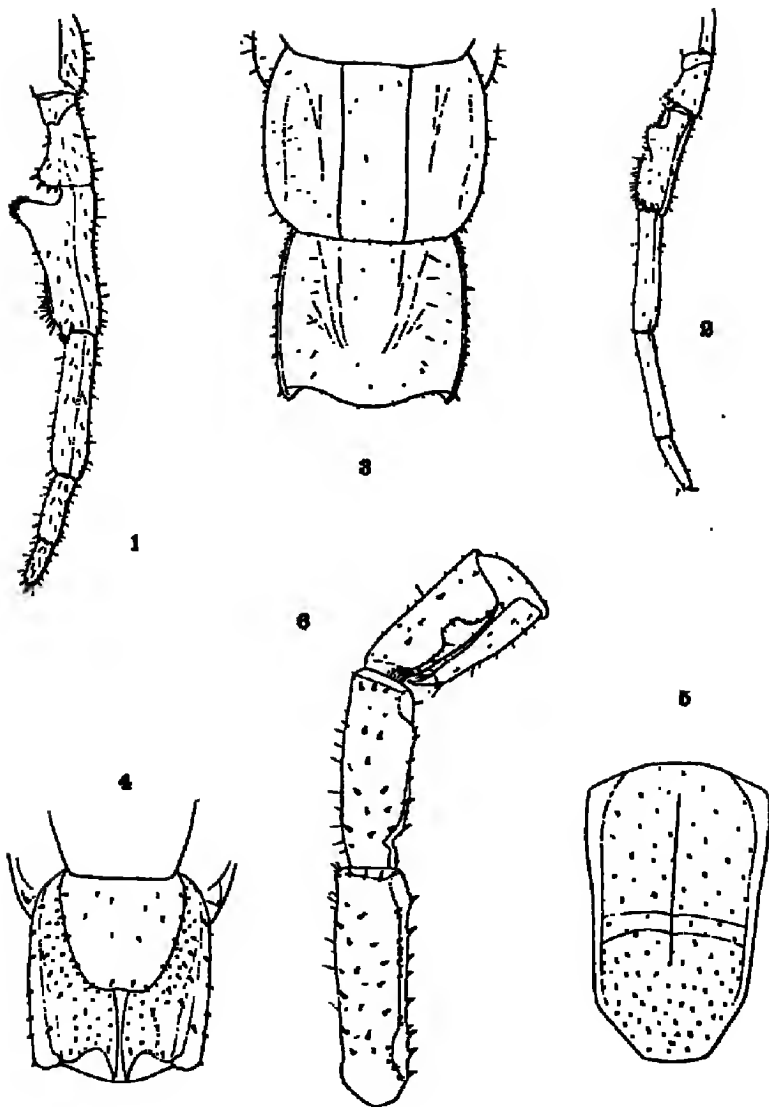
Fig. 5. Fourteenth ventral plate.

Fig. 6. Right anal leg, mesal aspect.









**CONTRIBUTION TO THE KNOWLEDGE OF MEALY  
INSECTS, GENUS PSEUDOCOCCUS, IN THE VICINITY  
OF CAPE TOWN, SOUTH AFRICA.**

By CHAS. K. BRAIN, F. E. S.

The material studied was mainly collected by the writer during 1910 and the first part of 1911. Two of the species, however, were collected by Mr. Chas. P. Lounsbury, as mentioned in the descriptions. Sixteen different host plants are involved, but *Pseudococcus capensis* was found on eleven of these, while particular attention was not paid to hosts for *P. longispinus*, which was found exclusively in greenhouses. It should be mentioned that the specimens were collected as noticed while engaged on other entomological work connected with the Department of Agriculture, and it is by no means implied that the seven species mentioned in this paper include all that are present in the Cape Peninsula.

To insure more accurate measurement of the segments of the antennae, and the setae of the anal lobes and anal ring, all specimens were stained by the Carbol Fuchsin method described in a separate section of this article. The photographs and drawings were prepared by the writer hoping that they would facilitate the determination of the species. At this first opportunity I wish to express my gratitude to Mr. Chas. P. Lounsbury, Chief of the Division of Entomology for the Union of South Africa, for much assistance in Entomological work, and also to Prof. Herbert Osborn, of Ohio State University, for his timely criticism and advice.

***Pseudococcus longispinus* Targ. 1867.**

*Dactylopius longispinus* Targioni. Studi sulle Cocciniglie 1867.

*Dactylopius arionidum* Signoret. Essai sur les Cochenilles. Ann. Ent. Soc. Fr. 1875.

*Dactylopius longifilis* Comstock. Ann. Rep. Conn. Agric. 1890. Washington 1891.

This well known insect (Fig. 1) can be readily recognized by its caudal appendages, but the following particulars are added to make the series uniform and to assist in the determination of slide material.

*Adult ♀*. Largest specimen found measured while alive 4.1 mm., and had caudal appendages 5.5 mm. long.

*Antennae*: Measurements in  $\mu$ .



Joints	I	II	III	IV	V	VI	VII	VIII
Range of measurements ...	54-80	58-82	61-81	30-50	40-62	30-48	40-50	1-110
Most common meas'rem'ts	60.62	65.67	70.74	36.38	46.48	38.42	44	102
Average of 20 meas'rem'ts	64	70	71	30	50	40	45	101

Fig. 1. *Pseudococcus longispinus* ♀

*Setæ of Anal Lobes:*  $110\mu$  to  $130\mu$ , with  $124\mu$  the most common length.

*Setæ of Anal Ring:*  $122\mu$  to  $148\mu$  with  $134\mu$  the most common length.

*Remarks:* This species is commonly found on ferns, etc., in greenhouses.

#### *Pseudococcus citri* Risso 1813.

*Dorthesia citri* Risso. Essai Hist. Nat. des Oranges, etc. Paris 1813.

*Coccus citri* Boisduval. Essai sur l'Entom. Hort. 1867.

*Dactylopius citri* Signoret Essai sur les Cochenilles 1875.

*Dactylopius brevispinus* (ex. p.) Targioni. Annali di Agricoltura 1881.

*Dactylopius destructor* Comstock Ann. Rep. Comm. Agr. 1880. Washington. 1881.

This species—the common mealy-bug of literature—is easily distinguished from *P. longispinus* by the absence of the long caudal filaments, and from the other species of the locality by the fact that the waxy secretion is most scant down the median dorsal line. Its general appearance is well shown in Plate XIV, Fig. 3, which is greatly enlarged. The seventeen lateral wax appendages are often more or less wanting in old rubbed specimens, especially those living in exposed positions.

*Ovisac:* Small, more or less spherical, at first covered by the body of the female. As the mass increases it is generally seen as a rounded mass protruding beneath, and in front of, the insect.

Amber yellow, 320-350  $\mu$  long, and 146-165  $\mu$  broad.

♀: Largest specimen found, with ovisac completed, measured 4.45 mm. long by 2.64 mm. broad.

Antennae: Plate XV, Fig. 5. Antennal segments, measurements in  $\mu$ .

	I	II	III	IV	V	VI	VII	VIII
measurements...	52-74	58-76	52-70	31-16	30-48	36-48	40-54	96-120
mean measurements	60.06	62.65	60.65	12	12	11	46	108
30 measurements	62.6	64.5	64	30.3	43.3	42.8	17.5	106.6

of Anal Lobes: 180  $\mu$  to 270  $\mu$  with 225  $\mu$  the commonest length.

of Anal Ring: 108-138  $\mu$  with 115  $\mu$  the commonest length.

The distribution of spines and pores round the anal lobes is shown in Plate XVI, Fig. 1.

Remarks: *P. citri* is one of the greatest worries of nursery-men on *Coleus*, and was also quite common in the Cape Peninsula on *Oleander*.

***Pseudococcus lounsburyi* n. sp.**

*Ovisac*: When complete entirely enclosing the adult ♀, large, elongate, oval, composed of threads which, when seen under the microscope have almost a glassy appearance; 4.5 mm. long, by 2.25 mm. broad. Large numbers of ovisacs were often found matted together between leaf-bases, sometimes forming a mass two inches long by almost as wide.

*Ora*: Closely surrounded by fibres of the ovisac; orange yellow, 340  $\mu$  long by 176  $\mu$  in diameter.

*Larvæ*: Newly emerged, are nearly transparent, showing but the slightest tinge of the usual purplish coloring (880  $\mu$  long and 260  $\mu$  broad; antennae transparent, of 6 joints.

*Male*: Puparium small, brownish white. Adult of the usual *Pseudococcus* ♂ form (see figure) with body purplish red in color, .9 to 1.020 mm. in length and .255 mm. across the thorax, the widest part of the body; legs and antennae pale yellow, and semi-transparent. Antennae of 10 joints, .564 mm. long, eyes black; caudal appendages, when living, two stout, .255 mm. long, and two more slender, nearly half as long. Males emerge November and early December.



Fig. 2.  
♂ of *Pseudococcus lounsburyi*,  
greatly enlarged.

**Adult Female:** At the time of spinning the ovisac, large, 3 mm. (4.1 mm. with caudal appendages) by 1.65 mm. broad, becoming somewhat narrower towards the anterior and posterior ends; color purplish, showing distinctly through the ashy white secretion; segmentation very distinct; legs and antennae very pale; lateral wax appendages absent, caudal ones stout at base, somewhat conical, snow white and appearing granular. Inner pair longer and stouter than the outer ones. Until the females attain approximately the size 2.4 mm. long by 1.1 mm. broad they remain free-moving. (Plate XIV, Fig. 4). After this the ovisac is commenced—a silky mass which ultimately completely envelopes the insect. This is spun from the posterior end forward, as shown in Figs. 5 and 6, until, in the end, it forms a complete covering for the female, and later the ova.

**Antennae:** Plate XV, Fig. 6.

Segments—measurements in  $\mu$ .

Joints.....	I	II	III	IV	V	VI	VII	VIII
Range of measurements....	56-66	64-72	43-52	26-36	33-48	20-30	34-42	8-100
Most common measurements	60	68	46	28	42	28	36	50-62
Average of 10 measurements.	61	69	47	28	42	28	37	62

**Setae of Anal Lobes.** 144 $\mu$  to 160 $\mu$  long (from 5 measurements).

**Setae of Anal Ring.** 104 $\mu$  to 128  $\mu$  long.

Unfortunately, although 35 specimens were mounted, nearly all the setae of the anal lobes were lacking. It commonly happens in clearing specimens in K O H etc., that a number of the hairs, spines, etc., are lost but I have never found it occur to such an extent as in this species. Plate XVI, Fig. 2 shows the distribution of spines and pores round the anal lobes.

**Type Slide:** On this slide are three specimens, arranged, with the slide in front of one as labeled, in the form of a triangle. The insect at the apex is here described as "a," the one at the left as "b," and the one on the right as "c."

**Specimen "a":** Size, mounted, 2.8 mm. long by 1.4 mm. broad.

Pores of derm small and scattered, sparingly supplied with small hairs, especially across the middle zones of segments. Hairs on dorsal surface more numerous and longer, sometimes attaining length of 90  $\mu$ .

**Antennal segments:** One antenna folded. Segments of other, in order 1 to 8, measured in  $\mu$  are 58, 68, 48, 36, 42, 27, 36 and 80. It should be mentioned that Segment IV, measuring, in this specimen 36  $\mu$  is the longest found in the whole series. The usual length for joint IV is about 28  $\mu$ .

**Setae of Anal Lobes.** 154  $\mu$ , 160  $\mu$ .

**Setae of Anal Ring:** About 128  $\mu$ .

**Legs:** The measurements of the legs on the right side of the insect—left side as mounted with ventral side up are given in  $\mu$ . It should be noticed that seven measurements are given, and the illustration shows the scheme adopted. The Coxa and trochanter are unsatisfactory as

measuring in many instances and the method adopted in the used here is to obtain measurements in direct lines from points main definite with different ways of folding of the legs in g. Hence the trochanter is measured with the femur.

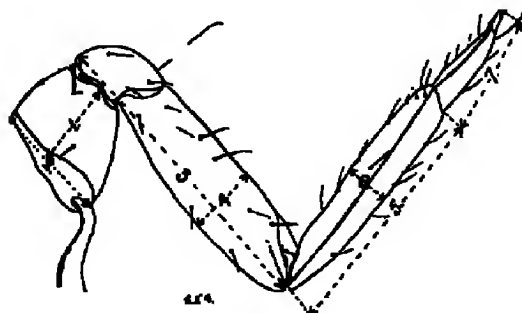


Fig. 3.

Right metathoracic leg of *Pseudococcus lonnsburyi* ♀ illustrating scheme of measurements.

The measurements in  $\mu$  are given in the following order:

1. Length of coxa.
2. Breadth of coxa across base.
3. Length of trochanter plus femur.
4. Breadth of femur.
5. Length of tibia.
6. Breadth of tibia.
7. Length of tarsus plus claw.

Prothoracic leg.....	83	129	281	76	100	38	106
Mesothoracic leg.....	83	121	304	70	205	40	106
Metathoracic leg.....	90	129	334	79	243	48	121

*Specimen "b"*: Size mounted 3.2 mm. by 1.6 mm.

The measurements of the segments of the antenna (one lacking) in this insect illustrate a very good average for the material collected. They are: 58, 64, 44, 26, 42, 28, 36 and 91  $\mu$ . The Setæ of the anal lobes unfortunately are missing, while those of the anal ring average from 120  $\mu$  to 128  $\mu$ .

*Specimen "c"*: Size mounted 3 mm. by 1.5 mm.

*Antennal Segments*: Right—56, 64, 43, 28, 33, 27, 38, 88. Left—62, 64, 43, 27, 38, 28, 36, 88.

The fifth segment of the right antenna in this insect measures only 33  $\mu$ . It is a coincidence that this is the least measurement found for this segment, and it is on the same slide as the specimen showing the maximum length for segment IV. One of the setæ of the anal lobes is missing. The one remaining measures 136  $\mu$ , while those of the anal ring average about 106  $\mu$ .

Host Plant: *Agapanthus umbellatus* L'Hérit.

Remarks: This species was first found by Mr. C. P. Con-  
bury on the leaf-bases of this plant in the grounds of dian  
House, Kenilworth, on September 10, 1910.

***Pseudococcus capensis* n. sp.**

*Orisac*: Large, 4.2 mm. long by 3 mm. broad, white, fibr

*Ora*: Bright orange yellow, 344  $\mu$ —390  $\mu$  long by 170  $\mu$ —190  $\mu$  broad.

*Adult* ♀: Largest specimens found were 4.2 mm. long and 1.86 mm. broad. Waxy secretion usually scant, lateral filaments short and slender; caudal ones (2), when insect is in sheltered spot, sometimes attaining half the length of body.

*Antennae*: Plate XV, Fig. 3.

Segments, measurements in  $\mu$ .

Joints....	I	II	III	IV	V	VI	VII	VIII
Range of measurements....	60-76	76-90	76-92	36-50	52-64	36-45	40-52	96-115
Most common meas'r'm'ts	68	80	80	40-42	56-62	40	44	104
Average of 20 meas'r'm'ts.	68	81.5	81	42	59	39	44	105.5

*Seta of Anal Lobes*: 117  $\mu$ —152  $\mu$ , most common length about 128  $\mu$ .

*Seta of Anal Ring*: 154  $\mu$ —180  $\mu$ , most common length about 160  $\mu$ .

Plate XVI, Fig. 3, shows distribution of glands, etc., round anal ring.

*Type*: Size mounted 3 mm. by 1.86. Dermis with small scattered pores on ventral surface, with scant short hairs. Dorsal surface with scattered, large pores, some at anterior end with hairs reaching 90  $\mu$  in length.

*Antennae*: Segments, Right—70?, 80, 72, 50, 53, 40, 13, and 110  $\mu$ . Left—75?, 80, 75, 45, 56, 42, 43, and 107  $\mu$ .

\* *Seta of Anal Lobes* about 117  $\mu$  long, those of *Anal Ring* about 160  $\mu$  long.

*Legs*: measurements in  $\mu$ .

Prothoracic leg....	83	129	304	91	228	38	111
Mesothoracic leg....	98	129	327	91	258	38	121
Metathoracic leg....	98	129	337	95	311	55	129

Remarks: This species was found on a number of different host plants, viz.: *Phytolacca dioica* Piper, *Albizzia lophantha*, *Solanum sodomæum* Linn., *Clematis vitalba*, *Pelargonium* sp., *Sonchus oleraceus* Linn., *Senecio vulgaris* Linn., *Malva parviflora* Linn., and *Oxalis corniculata* Thunb. It was also found on vines at Constantia and on stored pumpkins at Stellenbosch. The following notes made at the time of collecting the material illustrate some phases of the life-history of this species:

(b) On *Phytolacca dioica* Piper, at Rosebank Station. July 1. Fruit clusters nearly all fallen. These were heavily infested with Mealy Bug, and on falling to the ground many of the adult females made their way back to the trunks of the trees. At this date many females are to be seen walking about the bark, while the trunks are quite noticeable from the number of ovisacs spun in the cracks of the bark. In the four trees there must be some thousands of ovisacs within five feet of the ground, while in one case they are numerous to a height of 25 to 30 feet.

(c) On *Albizzia lophantha*. In winter this species is commonly clustered on the crowns of young seedling plants of this species immediately below the surface of the ground. Others are found in cracks in the bark of larger trees and later in the season when the leaves and flowers appear the insects are scattered over the whole tree. Large numbers of ovisacs have been found matted together in the seed pods.

(c) On *Stored Pumpkins* at Stellenbosch. Dec. 15, 1910. On this date I collected full-grown females (3-4 mm.) from pumpkins of the Turk's Head variety which had been stored on a roof (galvanized iron) for some months. Numerous completed ovisacs were present. All specimens were below the pumpkins and had the appearance of having remained there for a long time. The pumpkins were exceedingly hard and dry and were on a hot, dry, exposed roof, but the insects were quite healthy looking and lively.

(d) On *Vines at Constantia*. Jan. 3, 1911. This material was collected by Mr. C. P. Lounsbury who states that at this date females of all stages were present in the vines but very few had entered the bunches themselves, which were small at that time.

***Pseudococcus wachendorffiae* n. sp.**

*Ovisac*: No definite ovisac was found, although where the adult ♀ was situated a definite white granular patch of waxy secretion was noticed on the plant.

*Adult ♀*: Largest specimen found measured while alive 4.1 mm. long and 1.9 mm. broad. The body was finely covered with granular secretion, white, but segmentation was still conspicuous. Lateral appendages of wax were absent, but a short caudal tuft was generally noticeable.

*Antennae*: Plate XV, Fig. 2.

*Segments*: Measurements in  $\mu$ .

Joints.....	I	II	III	IV	V	VI	VII	VIII
Range of measurements....	60-68	44-64	32-56	18-26	28-44	20-28	28-36	16-46
Most common measurements	60	60	44	24	36	24	28.32	40
Average of 10 measurements	64	56	43	23	36	24	31	28

*Setæ of Anal lobes:* 154  $\mu$ -180  $\mu$  with commonest length about 160  $\mu$ .

*Setæ of Anal ring:* 115  $\mu$ -144  $\mu$  with commonest length about 136  $\mu$ .

Plate XVI, Fig. 4, shows distribution of pores etc., round anal lobes.

*Type:* Specimen mounted measures 2.7 mm. long by 1.8 mm. broad.

Dermis, with numerous scattered pores and numerous short hairs or spines, especially along the median zones of the segments. On the dorsal surface, towards the anterior end, the hairs are numerous and longer, some reaching 72  $\mu$  in length.

*Antennæ:* The segments measured in  $\mu$  are: ?, 53, 43, 25, 28, 27, 32 and 80  $\mu$  on one side, and 64, 56, 44, 22, 32, 26, 31 and 80  $\mu$  on the other. The *Setæ* on the anal lobes are 155  $\mu$  and 158  $\mu$  while those of the anal ring average about 136  $\mu$ .

*Legs:* Measurements in  $\mu$ .

Prothoracic leg.....	91	121	334	83	212	42	91
Mesothoracic leg.....	106	136	342	91	235	45	83
Metathoracic leg....	129	152	364	91	281	54	114

**Remarks:** This species was only found on *Wachendorfia paniculata* Linn. The material was collected by the writer on Newlands Flats, about eight miles from Cape Town, on October 3, 1910. The mealy-bug was found on thirty per cent of the plants of this kind pulled up in an area of about two hundred yards square, but was not once found above the surface of the ground. It was between the leaf-bases, and extended from half to one and a half inches down. The ground was composed of white sand. Ants were in constant attendance and had in some cases raised the sand slightly around the stem of the plant. It was this fact that attracted my attention. It was noticeable that some half-mile away, where the plant was fairly plentiful again, no mealy-bug could be found. It might be suggested that the colonies of ants have something to do with the distribution as the plants are generally somewhat scattered.

#### *Pseudococcus muralis* n. sp.

*Ovisac:* Spherical, 2.3 mm. in diameter, white, fibrous. Large clusters of ovisacs occur sparingly, and are generally overrun by ants. Plate XIV, Fig. 1 shows such a cluster three-fourths natural size.

*Ova:* Orange yellow in color, oval, averaging 240  $\mu$  long by 180  $\mu$  wide.

*larva:* (a) newly hatched, orange yellow, legs and antennae pale, parent. The larvae in this stage are very active, oval in form, being 358  $\mu$  long by 170  $\mu$  broad. (b) later, 544  $\mu$  long by 255  $\mu$ . Antennae of 6 joints, about 170  $\mu$  long. Eyes conspicuous, black. Measurements of the larval antennae in  $\mu$  gave the following lengths for segments: 20, 22, 16, 18, 20 and 68  $\mu$ . Larvae began to emerge from eggs kept at room temperature on October 25th.

*Pupa:* not found.

*Adult ♀:* (Plate XIV, Fig. 2) small; largest specimen, with completed oviscaptes, was 1.9 mm. long by 1.13 mm. broad, slatey-gray in color; waxy secretion scant but segmentation conspicuous. Lateral appendages were absent but usually four caudal ones present, the longest of which measured 330  $\mu$ . Color in boiling K O H black, then purple.

*Antennae:* Plate XV, Fig. 1.

Segments: measured in  $\mu$ .

Joints .....	I	II	III	IV	V	VI	VII	VIII
Range of measurements....	32-42	34-40	26-34	16-23	21-25	20-21	25-32	72-84
Most common meas'r'm'ts	40	38	30	20	24	22	28	82
Average of 10 meas'r'm'ts.	39	38	31	20	23.5	22	29	82

*Setae of Anal Lobes:* 120 $\mu$ -150 $\mu$ , most common length about 130  $\mu$ .

*Setae of Anal Ring:* 90  $\mu$ -120  $\mu$ , most common length about 108  $\mu$ .

Plate XVI, Fig. 5, shows the distribution of spines, etc., round anal lobes.

*Type Slide:* This slide has two specimens mounted on it, but the one to the left as slide is labeled is considered the type specimen. (Specimen A).

*Specimen A:* Size mounted 1.6 mm. by 1.14 mm.

*Dermis:* Pores very scattered. Those on the dorsal surface generally larger than those of ventral surface. On both surfaces are a few scattered hairs. Some of these on the dorsal surface, towards the anterior end are long and very slender, reaching in a few cases 90  $\mu$  long.

*Antennae:* Right—31?, 31, 26, 20, 24, 20, 25 and 78  $\mu$ . Left—10, 35, 26, 16, 24, 20, 25, and 80 $\mu$ .

The setae of the anal lobes are 128  $\mu$  long, while those of the anal ring average about 112  $\mu$ .

*Legs,* measured according to scheme given with description of *P. lounsburyi* are:

Prothoracic leg. . . . .	45	75	150	60	98	30	84
Mesothoracic leg.....	45	76	170	60	98	30	98
Metathoracic leg.....	53	84	190	60	128	28	106

*Specimen B.* Size mounted is 1.67 mm. long and 1.18 mm. broad.

*Antennae:* Right—?, 36, 32, 17, 24, 22, 30 and 72  $\mu$ . Left—?, 38, 31, 16, 24, 20, 27, and 78  $\mu$ .



The Setæ of the anal lobes are  $128\ \mu$  and  $134\ \mu$  long while those of the anal ring seem to vary between  $98\ \mu$  and  $104\ \mu$ .

Host Plant: *Muraltia heisteria*, D. C.

Remarks: As far as is known this small species has only one host plant. It was found by the writer on the Cape Flats east of Newlands and Rondebosch.

***Pseudococcus fragilis* n. sp.**

This material was collected on oranges at Constantia by Mr. C. P. Lounsbury on October 19, 1910. Unfortunately, I have no notes with me concerning the living insect, and have no particulars of the ovisac, etc. The insect is so distinct from the other species collected in the district, however, that I will give the measurements from the slide material, and hope to complete the description on my return to the Cape.

*Adult ♀*: Size of largest mounted specimen 4 mm. long and 2.4 mm. broad. The integument appears exceptionally delicate, the antennæ unusually long, (Plate XV, Fig. 4) and the spines and setæ unusually thin and fragile, and, in mounted specimens, very much bent.

**Antennal Segments:**

Joints.....	I	II	III	IV	V	VI	VII	VIII
Range of measurements.....	64-70	72-90	80-100	56-62	60-84	50-64	48-60	101-120
Most common meas'r'm'ts	64	70	88	58	64	52	58	112
Average of 10 meas'r'm'ts.	66	80	90	57	70	53	55	111

*Setæ of Anal Lobes* are about  $230\ \mu$  long.

*Setæ of Anal Ring* are about  $192\ \mu$  long.

Plate XVI, Fig. 6, shows the distribution of spines, etc., round the anal lobes.

*Type*: Size mounted 4.0 mm. by 2.4 mm.

The pores and hairs on the dermis are scant and the latter are very thin. Near the anterior end, on the dorsal surface are a number of long delicate hairs, some of which reach a length of  $160\ \mu$  or possibly more.

*The Antennal Segments* measure: Right—64, 84, 96, 58, 74, 54, 51,  $118\ \mu$ . Left—64, 80, 96, 60, 80, 50, 56,  $116\ \mu$ .

The Setæ of the anal lobes measure approximately  $224\ \mu$  long, while those of the anal ring probably average about  $196\ \mu$  in length.

*Legs* measured according to scheme given for *P. lounsburyi*.

Prothoracic leg.....	121	167	361	106	250	38	136
Mesothoracic leg.....	120	167	417	102	304	38	141
Metathoracic leg.....	120	159	432	106	342	45	141

Host Plant: Orange.

KEY TO THE COCCIDAE FOR DETERMINATION, WITH SPECIAL  
REFERENCE TO THE GENUS *PSEUDOCOCCUS*.

During 1910, and the first part of 1911 the writer collected material in the vicinity of Capetown, South Africa, for the purpose of determining what species of the Genus *Pseudococcus* Woodward, were to be found in that locality. Specimens were obtained from twenty-one different kinds of plants, and a series of experiments made to determine which was the most satisfactory way of mounting them for study. Everyone who has worked with this genus will appreciate the difficulties encountered in the determination of species, and also the unsatisfactory nature of the majority of the descriptions given for described species. Most of these descriptions simply give the size, color, amount of waxy covering, antennal formula and host plant. If different descriptions of the same species are available it will at once be seen how variable are the facts given. Smith\* (1911) discusses this fact and shows the futility of many of the specific characters generally used.

Notwithstanding the fact that the mere antennal formula is of little value, the relative size of the antennæ as a whole, and of the segments separately, is a very useful character *when the actual measurements are given*. This, together with the average size of the adult ♀ at the time of oviposition, the comparative lengths of the setæ of the anal lobes with those of the anal ring, the nature of the integument and the distribution of pores and spines, furnish, I believe, the best characters obtainable.

For all these characters, except the length of the individuals, specimens cleared and mounted in the usual manner are not the most satisfactory. With regard to the joints of the antennæ especially does this apply, for such specimens are too clear, and the distinction between the joint itself and the conjunctiva is indistinct. Referring to this fact, Smith (loc. cit. p. 313) states: "The chitin is not continuous from one segment to the next and consequently the portion between the chitinous parts of the segments, the conjunctiva, is not visible or only slightly so in well cleared specimens. Consequently, in making

P. E. Smith. "Specific Characters of the Genus *Pseudococcus*." Ann. Ent. Soc. Am. IV, No. 3. Sept., 1911.

measurements, the determination of the end of a segment will be only approximately at the center of the conjunctiva. This difficulty will be increased if there are some bends in the antennæ."

To overcome this difficulty a number of methods of staining were tried, but the one given below proved the most satisfactory and gave excellent mounts.

Puncture the specimens with a coarse needle or the point of a fine scalpel and treat with K O H in the usual manner. After washing in water transfer to strong Carbol fuchsin and leave until deeply stained. Specimens may be left in this for an hour or more, or over night if the stain is diluted. Wash in weak alcohol and bring up to 95% or absolute alcohol. By the time this stage is reached the specimens should be uniformly deeply colored but translucent. Place in clove oil to clear and bleach. The action of this is slow, and the condition of the specimens can be regulated so that any degree of staining can be retained. If left sufficiently long the integument will be quite clear except for the more highly chitinised parts, i. e., antennæ, legs, mouthparts, spines and pores. At this stage the specimens make exceedingly beautiful slides and quite satisfactory mounts to work with. Specimens should be passed from clove oil through xylol into balsam. The illustration shows a photograph from such a mount.



Fig. 4. Microphotograph of right antenna of *Pseudococcus* sp. showing pseudo-articulation of segment viii.

Armoured scales, (also Mallophaga, Pediculidæ and other soft-bodied insects) may also be improved for purposes of study by a very simple method. After treating with K O H and bringing through the alcohols the specimens should be cleared in Beechwood Creosote to which a little Picric Acid has been added. This turns the creosote a bright brown but does

- interfere with its clearing properties. By this means chitin  
ained a bright sulphur yellow. From this the specimens  
be mounted direct, but are probably better when passed  
ly through xylol or clear creosote into balsam.

EXPLANATION OF PLATES.

- XIV. Fig. 1. Cluster of ovisacs of *Pseudococcus muraliae*  $\frac{2}{3}$  nat. size.  
Fig. 2. *P. muraliae*, ♀. Fig. 3. *P. citri*. Fig. 4. *P. lounsburyi*, ♀♀, before ovisac  $\frac{1}{2}$  begun. Fig. 5. *P. lounsburyi*, ♀,  
with ovisac begun. Fig. 6. A slightly later stage.
- XV. Antennae. Camera lucida drawings, all of equal magnification, for  
comparison of size.
- PLATE XVI. Fig. 1. *Pseudococcus citri*. Fig. 2. *P. lounsburyi*.  
Fig. 3. *P. capensis*. Fig. 4. *P. wachenborfiae*. Fig. 5. *P. muraliae*.  
Fig. 6. *P. fragilis*.

NEW POSTAL REGULATIONS.

The following statement of the revised regulations of the Post-office department concerning the transmission of insects through the mails has been kindly supplied by Dr. L. O. Howard, Chief of the Bureau of Entomology:

"Queen bees and their attendant bees, when accompanied by a certificate from a State or Government inspector that they have been inspected and found free of disease; beneficial insects, when shipped by departments of entomology in agricultural colleges and persons holding official entomological positions; other live insects, when addressed to the Bureau of Entomology of the United States Department of Agriculture, to departments of entomology in State agricultural colleges, and to persons holding official entomological positions, and dried insects and dried reptiles may be sent in the mails when so put up as to render it practically impossible that the package shall be broken in transit, or the persons handling the same be injured, or the mail bags or their contents soiled.

"Nursery stock, including field-grown florists' stock, trees, shrubs, plants, vines, cuttings, grafts, scions and buds (which may carry injurious insects) may be admitted to the mails only when accompanied by a certificate from a State or Government inspector to the effect that said nursery stock has been inspected and found free from injurious insects."



1. Ovisacs of *P. muraltiae*.



4. *P. lounsburyi*.



2. *P. muraltiae*.



5. *P. lounsburyi*.



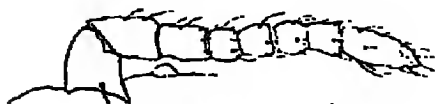
3. *P. citri*.



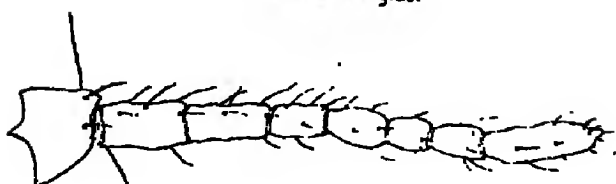
6. *P. lounsburyi*.



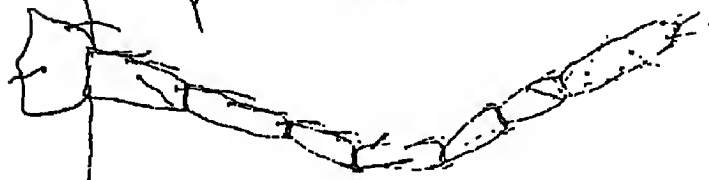
*P. muralis.*



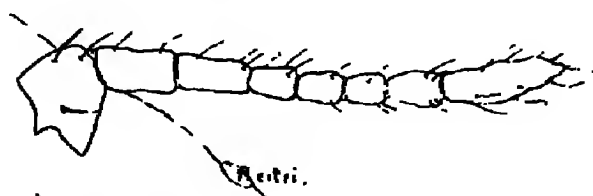
*P. wachendorffii.*



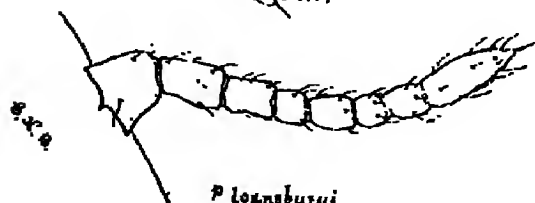
*P. capensis.*



*P. fragilis.*



*P. citri.*



*P. loansburgi.*

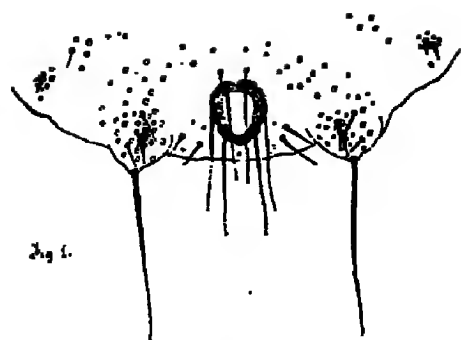


Fig. 1.



Fig. 2.

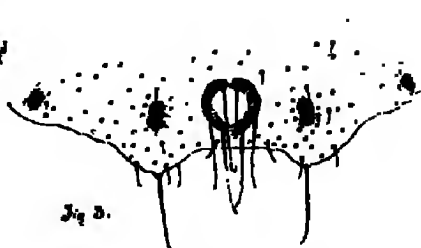


Fig. 3.

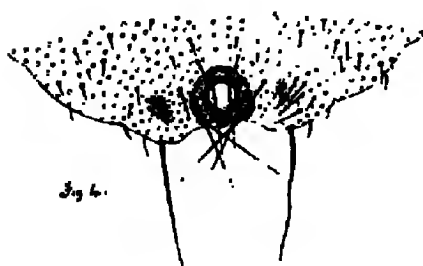


Fig. 4.

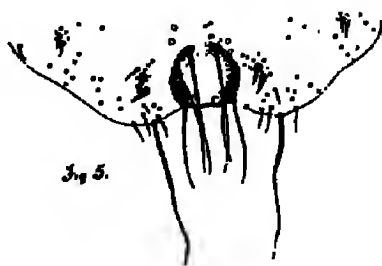


Fig. 5.



Fig. 6.

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**BRAZILIAN ICHNEUMONIDÆ AND BRACONIDÆ  
OBTAINED BY THE STANFORD EXPEDITION.\***

STANFORD EXPEDITION TO BRAZIL, 1911.

J. C. BRANNER, Director.

By CHARLES T. BRUES.

All of the species considered in the present paper were obtained by an expedition undertaken by a number of naturalists from Stanford University. The party was led by Prof. J. C. Branner, and during a sojourn of several months, they visited a number of regions where little or no entomological collecting had previously been done. Mr. William M. Mann accompanied the expedition as entomologist, and as might be expected, many of the Parasitic Hymenoptera obtained prove to be undescribed.

I have not been able to deal with every species, for example, members of the genus *Ophion*, as it is quite impossible to recognize with certainty some of the forms described by Fabricius and other of the earlier writers.

A number of genera are here recorded from South America for the first time, and it has been found necessary to propose new genera in several instances for the Brazilian forms.

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\*Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 55.



## Family ICHNEUMONIDÆ

## Subfamily ICHNEUMONINÆ

***Cryptopyge obtusa* Kriechbaumer.**

Berliner Entom. Zeitung., Vol. 43, p. 128. 1898.

There is a female of this species from the Rio Madeira (Madeira-Mamoré, R. R. camp 43).

Kriechbaumer attributes the species to South America with some doubt, but there can be no question regarding the identity of the present female. The antennæ, broken in Kriechbaumer's type, are enlarged from the twelfth joint.

***Tetragonochora cetepurange* sp. nov.**

Male. Length 12.5 mm. Orange yellow, marked with black, the head, pleuræ and venter paler yellow. The black markings are as follows; head above the posterior foramen over the vertex nearly to the antennæ, the yellow extending farther upward on the sides of the frons and the orbits where it attains the level of the lower ocellus, on the temples it descends lower, next to the eye, passing the level of the lower ocellus; antennæ; mesonotum on its posterior two-thirds; scutellum with a large spot medially that attains the base, but not the sides nor apex; abdominal petiole at the middle with a V-shaped spot; second, third and fourth abdominal segments each with a broad band that does not attain the sides; fifth segment, except the sides; sixth and seventh and eight segments entirely; posterior knees; posterior tarsi, and apical three joints of middle tarsi. Fore wings deep fulvous on the basal half, then nearly hyaline to the black apex which begins just before the middle of the second section of the radius. Hind wings pale yellowish with blackened tips. Wing veins fulvous before the stigma, piceous beyond; stigma fuscous. Antennæ beyond the middle with the joints dentate below. Head deeply excavated above the antennæ, just below the median ocellus with a transverse tubercular elevation; face on each side with a shallow depression, separated by a median raised portion; clypeus not separated, but with a small, very deep circular impression on each side above, its lower margin straight medially and produced into an angular tooth at each lateral angle. Mandibles with two subequal black teeth. Head entirely smooth and shining, margined behind. Mesonotum minutely punctulate, the middle lobe prominent in front. Scutellum sparsely punctate anteriorly, longitudinally striated on its posterior half; margined laterally and separated from the mesonotum by a deep, longitudinally striated depression. Metathorax punctate; the superomedian area defined anteriorly, but open behind; pleural carina complete to the base of the hind coxa. Abdominal petiole aciculate, its spiracles almost linear, near the tip; second segment aciculate medially and deeply punctate near the lateral margins; third segment with same sculpture, but much finer; remainder of abdomen very finely and sparsely punctulate. Wings with four sided, obliquely trapezoidal areolet. Submedian cell longer than the median by nearly

and the length of the basal nervure; discoidal vein arising at the third of the second discoidal cell; transverse median vein of hind wing broken almost at its extreme apex.

One male collected by Mann and Baker, at Kete Purange, near Manaos, Brazil.

This species is related to *I. annulata* Brullé from Guiana from which it differs in structure and slightly in color, although of quite similar color-pattern.

#### Subfamily CRYPTINÆ

#### *Megaplectes branneri* sp. nov.

Male. Length 16 mm. Ferruginous, the head and anterior part of the thorax black with yellowish white markings. The entire face and mouthparts are pale, as well as the inner orbits above the antennæ, those behind the upper part of the eye, and the cheeks. The prothorax is also lined above and below, the mesopleura at its anterior upper angle, the scutellum on its sides and behind, and the whole postscutellum and the tegulæ pale. Antennæ black, with broad whitish annulus near the apex. Legs pale yellow, the four posterior ones ferruginous to the tips of the femora. Fore femora along the lower edge, last two joints of fore tarsi, a streak apically below on the middle femur, the middle tibial spurs, last three tarsal joints; second trochanter of hind leg, tip of femur, inner side of tibia and its spurs piceous or black. Wings pale ferruginous, stigma and veins black. Head smooth, impunctate, face with a longitudinal depression each side of the median line terminated below by the large clypeal foveæ; anterior edge of clypeus truncate, very faintly produced at the middle. Antennæ about as long as the body, slender and tapering, the first joint of the flagellum four times as long as thick, following decreasing in length; those toward the middle of the flagellum twice as long as thick; all except a few basal joints slightly nodosely thickened near their tips as in certain genera of Jopini although not so distinctly. Maxillary palpi with the second joint triangularly enlarged, the fifth joint very slender, nearly as long as the two preceding; labial palpi simple. Mesonotum finely, confluent punctate, without parapsidal furrows; scutellum more coarsely and sparsely punctate. Metathorax armed with a pair of unusually large and stout erect lateral spines; incompletely areolated; pleural carinæ complete, very strongly and evenly curved; basal pleural areas complete, sparsely punctate; basal median one smooth medially; hexagonal in position, but open behind, as its sides are prolonged as parallel carinæ the entire length of the melanotum; surface behind the areas transversely rugose, most roughly so behind the lateral spines. All pleuræ shining, more or less punctulate. Metathoracic spiracles elongate, four times as long as broad. Mesoepisternal groove distinct only in front. Abdominal petiole smooth and shining, with a very few scattered punctures on the sides of the post-petiole. Second segment with deep gastrocoeli, smooth at the very base; densely finely punctate elsewhere; third segment similarly punctate except at tip; following segments

faintly punctulate. Second to fifth ventral segments with 1 fold. Body of abdomen lanceolate, the second segment one-half longer than the third. Legs rather slender. Wings with the submedian cell longer than the median; discocubital vein with a faint stump of a vein near the middle. Arcolet of moderately large size, slightly oblique, due to the insertion of the recurrent nervure beyond its middle; discoidal vein broken below the middle; transverse median vein in hind wing broken at its lower third.

Pará, Brazil. W. M. Mann. Named for Professor J. C. Branner, the director of the expedition.

This species exhibits an entirely different color scheme from its European congener, but agrees well in the more important structural details. It is the second species to be described and looks much like a genuine *Ichneumon* except for the palpi and spined metathorax.

*Cryptus heathi* sp. nov.

Female. Length 10 mm. Ovipositor nearly as long as the abdomen, exclusive of the petiole. Head, thorax and antennae black, with yellowish-white markings; abdomen ferruginous, with narrow apical buff bands on the segments. The pale markings on the head and thorax are as follows; labrum, clypeus, except medially below; broad orbits, nearly meeting below the antennae and covering the entire head behind below the vertex; joints 9-12 of antennae; anterior edge of prothorax; lateral edges behind; medial spot on mesonotum; both scutellums; tegulae; median stripes on metathorax behind carina, greatly widened behind; broad oblique stripe on mesopleura; another on posterior part of metapleura; spot behind wings; and a short stripe ventrally in front of each hind coxa. On the abdomen the white is at the base and apex of the petiole and as a narrow apical band on segments 2-7. The fore legs have the coxae white, with black base and black spot in front and the basal trochanter white with black spot in front, the femur, tibia and tarsus fulvous with black stripe on femur above and last tarsal joint piceous. Middle legs pale ferruginous, with black spot on basal trochanter above, stripe on femur above and last tarsal joint piceous. Hind legs ferruginous, the apical two tarsal joints and tip of tibia blackened, and the three basal tarsal joints white. Wings hyaline, with piceous stigma and veins; the apex lightly infuscated and a narrow, irregular fuscous band just before the third discoidal cell, not ascending above the basal vein. Antennae slender, 24-jointed, as long as the body; the joints very short apically, but much lengthened at the base of the flagellum; the first flagellar joint nearly as long as the eye and over six times as long as thick. Head twice as broad as thick; shining, finely margined behind, shining, sparsely punctate above the clypeus; the latter truncate; labrum exposed as a broad lobe; mandibles fuscous, black below; palpi pale, slender. Mesonotum finely, deeply punctate, the parapsidal furrows distinct and the median lobe produced forward

lateral ones. Scutellum nearly flat, punctulate. Metathorax rounded above, finely closely punctate anteriorly, microscopic-transversely rugose-aciculate behind, near the basal third with an arcuate transverse carina; no trace of lateral projections or spiracles small, circular, behind them a very fine longitudinally lined line to the base of the coxa. Pro- and mesopleurae punctulate, smooth space below the insertion of the wings. Abdominal shining, smooth, nearly straight below, bent above at the middle, with a longitudinal impression on each side, but without distinct carinae; twice as broad as the base; spiracles barely behind the middle, second segment very finely, almost confluent punctate, following segments becoming smoother till at the tip the surface is not sculptured. Legs long and slender, the fore tibiae swollen and greatly constricted at the base; fourth tarsal joint on all the legs very short and deeply divided for the insertion of the fifth. Wings with the stigma very narrow, radial cell narrow, as long as the cubito-discal; areolet small, scarcely narrowed above and with the second transverse cubitus less distinctly colored than its other sides; cubito-discal vein not broken; recurrent nervure received at the middle of the areolet; discoidal vein broken a short way above the middle; submedian cell shorter than the median; transverse median vein in hind wing broken well above the middle.

Independencia, Parahyba, Brazil. (Mann and Heath).

This is a very pretty species of intricate color pattern which resembles *Callicryptus* in the form of the tarsi, although it is otherwise very different. The areolet is unusually small, and recalls that of the *Mesostenini*. The color is also similar to certain *Mesostenines*, but I am quite positive that it is correctly located here.

***Mesostenoides* (?) *crassus* sp. nov.**

Female. Length 12 mm. Ovipositor one-half longer than the petiole of the abdomen. A stout species, with the general habitus of a *Cryptus*. Black, with joints 8-15 of the antennae white above; a white median spot behind on the fifth to seventh segments of the abdomen, smallest on the fifth and largest on the seventh; legs, including coxae bright ferruginous, the hind pair black beyond the trochanters, the middle pair beyond the knees, and the fore pair on the last tarsal joint; basal abdominal segments margined behind with rufous, especially below; wings hyaline, faintly infuscated; palpi fuscous at tips. Head broader than the thorax, nearly three times as broad as thick, arcuately excavated behind; subopaque. Front impressed and shining above the antennae, with a fine median carina from the ocelli to the antennae; cheeks and lower part of head behind the eyes smooth and shining. Mesonotum with distinct, sharp, but not broad parapsidal furrows which are strongly convergent behind; middle lobe scarcely elevated above the lateral ones. Scutellum slightly convex, margined at the sides of the base which is crossed by a broad, deep, longitudinally

fluted groove. Metanotum as long as the mesonotum, gradually declivous and impressed behind along the middle, the upper angles produced into sharp, pale-tipped thorn-like spines. One complete, transverse angulated carina just behind the spiracles and trace of a small median basal area. Spiracles elongate, over twice as long as broad; position of pleural carina indicated by a fine denticulate line. Surface of metanotum rugulose, with distinct transverse aciculations medially behind, its pleurae very finely roughened. Mesopleura: the posterior margin with a grooved line which is crenate on its lower half; also with an arcuate linear impression above the center. Abdomen smooth, but opaque except on the petiole. Latter much broadened behind, the tip nearly four times as broad as the base; spiracles just before the posterior third; two carinae above each carina which grow weaker apically; center of broadened portion longitudinally depressed. Second segment the longest, one-fourth shorter than the petiole, longer than broad at tip; following transverse. Legs stout, not much elongated. Wings with black, narrow stigma and black veins. Median and submedian cells of equal length; cubito-discal vein broken, but little angulated by a slight tubercle. Areolet small, open, receiving the recurrent nervure near its outer angle; discoidal vein broken at the middle.

One female from Camp 39, Madeira-Mamoré R. R.

The generic reference is somewhat doubtful as the species has the stout antennae and heavy-set body of a true member of the Cryptini. The areolet is so small, however, not closed externally, and of such characteristic Mesostenine form, that I think the species must be placed in this tribe, although it will probably find a place in a new genus.

#### **Crypturopsis Ashmead.**

There are two species in the collection obtained by the expedition, separable as follows:

1. Wings darker at tips; abdomen banded with black.....*minor* sp. nov.  
Wings not darker at tips; abdomen not banded with black...*brasiliensis* sp. nov.

#### **Crypturopsis brasiliensis sp. nov.**

Male. Length 11 mm. Head and thorax black with yellowish-white markings; abdomen and four anterior legs ferruginous; hind legs black beyond the trochanter. Wings subhyaline. The pale markings are as follows. Head both before and behind, below the level of the antennae; inner orbits to the ocelli; large spot on each side of prothorax before and small one behind; four very much abbreviated longitudinal streaks on the mesonotum behind; spot on scutellum, a spot on each side of metanotum inward from the spiracle and a larger triangular one behind on each side; tegulae, dash beneath them; two broad horizontal stripes on mesopleura; small basal and large medial spot on metapleura; middle part of fore coxa and middle coxa (except for irregular ferrugin-

arks). Fore and middle legs fulvous, paler apically and with the basal joint black on the fore and the last two on the middle pair. Coxæ and a part of their trochanters ferruginous. Abdomen fulvous except for the blackened tip of the petiole and small black spots on segments 2-6, becoming obsolete on the later segments. Antennæ and veins black. Head as broad as the thorax, nearly three times as broad as thick, rather thin and acute above; vertex punctulate; antennal impression with a median carina and a few irregular radiating lines extending from the anterior ocellus; much deeper and shining just above the antennæ. Face slightly elevated medially, coarsely punctulate. Antennæ 36-37 jointed evenly tapering to the apex, basal flagellar joint three times as long as thick, those at the middle twice as long as thick, and near apex, nearly quadrate. Clypeus at each upper angle with a fovea connected with the eye by a fine black line. Mandibles black at tips; palpi pale. Mesonotum closely punctate, without parapsidal furrows although there is a broad rugulose-reticulate streak in their place and between these behind are several short longitudinal striæ. Scutellum very convex, finely punctulate, with a broad, deep fluted furrow across the base which has high raised lateral margins. Metathorax reticulate-rugose, somewhat longitudinally depressed along the median line, its spiracles oval, twice as long as wide. Basal transverse carina present on each side, but curving forward to the margin on each side before attaining the median line; sides with a shallow groove from the spiracle to the base of the coxa, lateral angles produced as blunt teeth, coinciding with the lateral angle of the triangular pale spot. Thorax seen from above, scarcely more than twice as long as wide, truncate posteriorly. Abdominal petiole longer than the metathorax, slender, smooth, the post-petiole longer than broad, with parallel sides; following segments smooth and shining, sparsely clothed with fine, fulvous hairs. Areolet very small, open apically; submedian cell slightly shorter than the median; discoidal vein broken above the middle; transverse median vein in hind wing broken at its lower fourth.

Manaos, Brazil, Mann and Baker. One male.

*Crypturopsis minor* sp. nov.

Male. Length 9 mm. Similar to the preceding, but with less fulvous on the abdomen, and with the wings very distinctly infuscated apically and the antennæ only 31-jointed. Front before the ocelli rugulose, the median carina present. Color of head and thorax as in the preceding species, except that the post-scutellum is pale and the metathorax entirely black above except for the small rounded lateral pale tubercular teeth. The fore legs are pale yellow with the femora fulvus and infuscated at base and tip; the middle coxæ are yellow before and ferruginous behind and the apical three tarsal joints are black. The abdomen has the petiole entirely ferruginous and the post-petiole narrowed behind, while the following segments are black, with fulvous apical bands. Median and submedian cells of equal length. Otherwise as in *C. brasiliensis*, with the thoracic spots all somewhat smaller.

One male from the Rio Madeira (Madeira-Mamoré E. R. Camp 39), Brazil, Mann and Baker.

These are the first two South American representatives of the genus to be discovered, although three have been described from North America by Ashmead. Only one of these, *dyarisi*, is known in the female sex.

*Cryptanura uniformis* sp. nov.

Male. Length 12 mm. Head, thorax, and antennæ black, with white ornamentation; legs and abdomen, except part of petiole, ferruginous. The white markings are as follows; annulus of 6-7 segments on antennæ; clypeus except lower and side margin, face, wide anterior orbits, broad stripe behind eye, and palpi; prothorax with an elongate spot on each side above and below; mesonotum with a round spot on the middle lobe behind the tegulae; elongate spot at side of scutellar fovea, scutellum and post-scutellum with side lines from each; metanotum with four broad longitudinal stripes on posterior half and a large spot at anterior angles; mesopleura with spot beneath wing and an elongate spot below; mesosternum with an elongate spot on each side. The legs also bear white on the anterior coxæ which are white in front and black behind, while the ferruginous middle coxæ are whitish in front. The ferruginous color is very uniform except that the anterior four legs and hind tarsi are more nearly fulvous. The apical joints of tarsi and the enlarged part of the abdominal petiole are piceous. The head is rather finely punctate on the face and clypeus, and the front bears two small spines above the antennæ; ocelli rather large, the posterior pair closer to one another than to the eye margin; eyes showing a very slight pubescence. Mesonotum deeply and sparsely punctate medially, nearly smooth on the sides, scutellum at the base with a very deep quadrate depression that is longitudinally striated. Metathorax with a complete transverse carina, joining a complete pleural one, and with a basal median and lateral area partly enclosed. Metathorax rugose-reticulate over its entire surface, more coarsely so behind, its spines long, slender, erect. Pro- and mesopleuræ smooth and shining, except for longitudinal striations below on the propleura and mesopleura. Mesopleura with a round impression medially behind, and rugose near the base of the coxa. Hind coxæ punctate near base. Petiole of abdomen very highly polished with a deep groove along the side passing below the spiracle which is situated just before the apical third of the petiole; following abdominal segments smooth, impunctate. Wings hyaline, infuscated at extreme tip; veins black, areolet very incompletely closed, the outer vein nearly hyaline. Submedian cell slightly shorter than the median; discoidal nerve inserted at the middle of the second discoidal cell; transverse median vein of hind wing broken at its lower fourth.

Described from a male taken by Mr. Wm. M. Mann, at Ceará-Mirim, Rio Grande do Norte, Brazil.

The present form approaches *C. hyalina* Brullé, which it resembles almost exactly in color, but the sculpture of the mesonotum is very different.

***Cryptanura striata* Brullé.**

Hist. Nat. Ins., Hyménop. Vol. 4, p. 244 (1846).

There is a male from Manaos (Mann and Baker) which appears to be this species, although differing from the female described by Brullé in having a short whitish stripe anteriorly on the inner edge of the lateral lobe of the mesonotum. The metanotal spines are blunt and the median metanotal stripes are abbreviated in front. The mandibles bear a large pale spot externally.

***Polycyrtus histrio* Spinola.**

Ann. Soc. Ent. France, Vol. 9, p. 155 (1840).

Brullé, Hist. Nat. Ins., Hyménop. Vol. 4, p. 214 (1846).

There are two males of this species from Manaos (Mann and Baker).

***Ophiogastrella* Gen. nov.**

Clypeus not pointed, truncate on the anterior margin. Eyes deeply, angularly emarginate on the inner margin. Face without a tooth, but with a faint cariniform tubercle just below the antennae. Ocelli very large. Head strongly transverse, narrowed behind the eyes, the vertex not margined behind, although the temples and cheeks are distinctly margined. Mesonotum without furrows or parapsidal impressions at the anterior margin. Metathorax short, abruptly declivous; smooth, finely punctulate, entirely destitute of carinae. Tarsal claws small, pectinate. Basal section of radius straight, not thickened; last section recurved. Submedian cell barely shorter than the median. Discoidal nervure arising at the upper fourth of the second discoidal vein. Disco-cubital vein very strongly bent, but not broken; its basal and apical portions running very nearly at right angles to each other. Cubito-discoidal cell without any dark chitinized spots. Transverse median vein in hind wing broken at its lowest fourth; the first section of the radius in this wing nearly twice as long as the recurrent nervure. Abdomen strongly compressed, very slender at the base, the first segment longer than the second, its spiracles placed at the apical third.

Type. *Ophiogastrella maculithorax* sp. nov.

This genus is related to *Pseudanomalon* Szépligeti, but differs in several important characters, particularly the form of the metathorax, which is neither elongate between the hind coxae nor rugose-reticulate. From other related genera it differs



by the position of the discoidal nervure (*Banchogastra*) and by the absence of a transverse carina on the metathorax (*Pycnophion et al.*).

*Ophiogastrella maculithorax* sp. nov.

Female. Length 7-8 mm. Head, thorax and legs pale yellow; metathorax, antennae at base and abdomen fulvus; remainder of antennae and indistinct stains at anterior angles of metanotum more or less piceous; a large spot enclosing the antennae and three broad longitudinal stripes on the mesonotum, deep blue-black. Of the mesonotal stripes, the lateral ones are abbreviated just before the anterior margin, and the median one extends from the anterior margin to just beyond the middle. Head smooth and shining; maxillary palpi slender, with the apical four joints subequal; face much narrowed below and the front above, by the eyes; the latter bare, almost attaining the base of the mandibles. Ocelli forming an equilateral triangle, separated by nearly their own diameter, the lateral ones very close to the eye margin. Entire thorax and pleurae shining, smooth and polished, except for very fine punctulation on the mesonotum and metathorax. Mesopleura with a moderately distinct punctate impression medially. Abdomen very slender to the base of the third segment, then strongly enlarged and compressed; first segment slightly longer than the second; third, fourth, fifth and sixth subequal, each one-fourth shorter than the second; following segments very short. Ovipositor one-third shorter than the third segment. Wings hyaline, veins piceous, stigma fuscous. Legs very long and slender, tarsal claws small.

Described from three females, collected at light by Mann and Heath, Independencia, Parahyba, Brazil.

This is a small, slender species easily recognized aside from its structural characters, by the striking maculation of the mesonotum.

*Ophionellus* Westw.

Thesaur. Entom. Oxon., p. 128, Pl. 21, figs. 3, 3a, 3b, 3c. (1871).

Mr. Mann obtained a specimen of this remarkable genus which represents a species different from *O. fragilis* Westwood, the type of the genus. It agrees very closely with Westwood's species and is surely congeneric, but on comparing it with Cresson's *Pharsalia virginensis*, I find that the latter is generically distinct, although the two genera have been regarded as synonymous.

The more salient differences may be tabulated as follows:

*Pharsalia* Cress. Sides of head behind the eyes rounded; antennae short, filiform, about 25-jointed, but little longer than the head and thorax; anterior wing with a distinct, although small stigma.

*Ophionellus* Westw. Sides of head with a large tooth-like projection behind each eye; antennae long, selaceous 40-50 jointed, nearly twice as long as the head and thorax; costa in anterior wing without thickening to form a stigma.

In addition to these differences the radial cell is much larger in *O. manni* than in *P. virginiensis*. The hind tibiae bear two apical spurs in each case, not one as is stated by Szépligeti, although there is only a single one on the middle tibia.

*Ophionellus manni* sp. nov.

Female. Length 20 mm. (extended). Black, the face, clypeus, cheeks and mandibles, except teeth, yellowish-white. Fore coxae and base of trochanters pale yellow, as are also the middle coxae beyond the middle; fore legs rufous, slightly darker toward the knees, and paler on the base of the tarsi; middle tarsi pale on base of first joint; last segment of abdomen testaceous below. Head smooth above on the sides but rugose medially; above the antennae with a deep depression which includes the median ocellus; face much narrowed below, only half as wide at the base of the eyes as at the antennae, its surface shining and finely punctulate. Eyes pubescent; oval, nearly twice as long as wide. Head behind shining, punctulate, densely griseous pubescent on and about the tooth-like projection behind the eye. Head behind highly polished, margined. Ocelli large, in an equilateral triangle. Antennae long and slender, 35-jointed; the first flagellar joint as long as the two following, rest gradually decreasing in length, those near the middle nearly three times as long as thick. Pronotum not visible from above, mesonotum much narrowed anteriorly. Its surface shining, reticulate, the carinae forming quite regular transverse rectangular areolae posteriorly. Scutellum sloping in a plane with the metathorax, flat, with a distinct large impression anteriorly. Metathorax long and strongly declivous, projecting considerably beyond the hind coxae and bifurcate at its tip where the abdominal petiole is inserted. It is densely covered with very short silvery pubescence, but shows a distinct median groove and a lateral carina extending for its entire length. Besides these the surface is distinctly, but not sharply reticulated, the areolae rectangular and transverse above and more or less polygonal on the sides. Pleurae densely silvery like the metathorax except for the narrow smooth propleura and for a deep linear depression extending from the middle coxa to the tegula. This groove is coarsely reticulated. Abdomen very slender, the petiole as long as the entire length of the thorax above, swollen on the apical two fifths where the spiracles are placed; its surface smooth and shining, the remainder of the abdomen dull; second segment as long as the first; third, half as long; fourth almost equalling the second; fifth equalling the second; sixth, seventh and eight short, decreasing in length; ovipositor as long as the third segment. Wings perfectly hyaline; radial cell as long as the cubito-discal cell, the second section of the radius and the transverse cubitus interstitial; second discoidal cell as high as long above, narrowed behind; costa

without a stigmal thickening; costal vein extending beyond the radial cell for half its length. Hind wing with a single subcostal cell, and the same continuation of the costal vein. This costal projection and the costal vein in the anterior wing black, but otherwise the venation is pale fuscous.

Described from one female collected by Mann and Baker on the Rio Madeira, Brazil, Camp 39, Madeira-Mamoré R. R.

This species differs from *O. fragilis* Westw. the only other described member of the genus, by the absence of a median groove on the mesonotum and by the entirely black tibiae. The second discoidal cell is also much shorter than the form represented by Westwood's plate.

#### Family BRACONIDÆ

##### Subfamily HELORIMORPHINÆ

##### *Helorimorpha brasiliensis* sp. nov.

Male. Length 4 mm. Entirely honey yellow, except the space between the ocelli, the entire antennæ, (except the 16th and 17th joints which are rufous) the apical fourth of the hind tibiae, the hind tarsi and the apical joint of the other tarsi which are black. Wings deeply infuscated, blackish; with black stigma and veins. Head twice as wide as thick antero-posteriorly, smooth except for fine punctulation on the face and clypeus and still finer on the head above. Eyes small, nearly circular, one half longer than the malar space. Front with a sharp median carina extending from the upper part of the face nearly to the ocelli; strongly excavated above the base of each antenna. Ocelli small, close together in a triangle, separated by only their own diameter. Maxillary palpi slender, pale testaceous; 5-jointed, with the basal joint very short. Antennæ black, with the 16th and 17th joints distinctly rufous; scape nearly as long as the first flagellar joint and twice as long as the pedicel; third joint as long as the scape, swollen apically; following joints becoming shorter and distinctly moniliform by the middle of the flagellum, where they are only half longer than thick; again toward the tip the joints become much more slender and lose their moniliform shape. Thorax pitted and reticulate as in other species of the genus, the metathorax deeply excavated medially on its posterior face. Abdomen slender, as long as the head and thorax; petiole curved near its apical third; very slender, but distinctly broadened toward tip both in dorsal and lateral view; spiracles at the posterior third; base not striated. Second segment covering all the remaining parts of the abdomen, smooth and highly polished; narrowly ovate; one third as broad as long and slightly higher than broad; much more strongly curved below than above. Legs formed as in the other species. Wings with the radius arising perpendicularly from the middle of the stigma, the latter nearly half as broad as long; second section of radius nearly half as long as the first and as long as the hyaline second transverse cubitus. Recurrent nervure joining the upper side of the second cubital cell in a straight

and the lower side originating at the same point so that the cell is three-sided. Submedian vein bordered by a hyaline streak as in *A. fisheri*.

One male collected by Mann and Baker; Manaus, Brazil.

This species is very similar to *II. fisheri* Viereck from eastern North America, and aside from the form of the antennae and wing venation differs only in its color characters. Mr. Mann's discovery of the Brazilian form is very interesting as the first representative of the genus was discovered in 1907 by Schmiedeknecht in Europe. Shortly afterwards it was found to occur in North America.

The four species so far described may be separated as follows:

1. Wings infuscated; body yellow.....2
- Wings hyaline; at least head black.....3
2. Scape of antennae yellow; flagellar joints twice as long as thick, .....*II. fisheri* Viereck
- Antennae entirely black, except joints 16 and 17; flagellar joints near middle of antennae less than twice as long as thick.....*II. brasiliensis* sp. nov.
3. Body entirely black.....*II. egregia* Schmiedeknecht
- Body, except head, yellow.....*II. mcclanderi* Brues

#### Subfamily MICROGASTRINÆ

##### *Mirax brasiliensis* sp. nov.

Female. Length 2.2 mm., ovipositor as long as the head-height. Head and thorax pale honey-yellow, abdomen somewhat lighter; legs whitish-yellow; antennae fuscous beyond the second joint; wings hyaline, with pale testaceous stigma and veins. Head transverse, twice as wide as thick, rounded on the temples behind the eyes; ocelli in an equilateral triangle, the space between them one third as great as that between the lateral ones and the eye margin. Front excavated on each side above the antennae, the depressions separated by an elevated triangular space that extends down to the level of the antennae. Face smooth; elevated medially, broadly so below and narrowly so above where the median line is almost carinate. Clypeus separated by a depressed line and with a large circular fovea on each side, its lower edge projecting but straight in front view. Mandibles black at tip, with two small teeth at apex. Antennae 14-jointed, as long as the body, tapering; scape short, but little longer than the pedicel which is slightly more than half as long as the first flagellar joint; joints beyond growing very gradually shorter, none less than two and one half times as long as thick. Eyes elongate-oval, much narrower below; malar space very short, with furrow. Mesonotum with crenulate furrows on its anterior half; sharply narrowed in front of the tegulae. Scutellum long, with parallel sides behind, but widened in front, its base with a curved, deep, linear impression which is crossed on its bottom by numerous carinae. Metanotum irregularly areolated; with a median carina that bifurcates behind, a straight transverse carina behind, and a curved carina on each side at the base

which marks off a large squarish space at each lateral angle, and with a lateral carina which passes just outside the round spiracle. Mesopleura with a carina along its posterior edge. Abdomen sessile, as long as the head and thorax. First segment with a L-shaped shining elevated portion; the latter swollen anteriorly and widened laterally along the margin of the segment; remainder of the segment paler, whitish; second segment twice as broad as long, longitudinally striated, also pale; following segments shining and smooth, fully colored. Ovipositor ferruginous, its sheaths broad, pilose, piceous with pale yellow bases. Legs moderately stout, blackened on the tips of the tarsi. Wings with broad stigma that is produced apically into a long, narrow point; marginal cell entirely wanting; submedian cell longer than the median by the length of the transverse median vein; recurrent nervure received at the apical fourth of the first cubital cell; second cubital wanting, except for a short stump of a vein that indicates its lower basal corner; subdiscoidal vein wanting. Hind wing with only the median and submedian cells, the latter less than half as long as the former.

One female, Ceará-Mirim, Rio Grande do Norte, Brazil (W. M. Mann).

This is possibly not congeneric with the type of *Mirax* on account of its parapsidal furrows, although otherwise similar.

#### Subfamily CHELONINÆ

##### *Chelonus brasiliensis* sp. nov.

Female. Length 3 mm. Black; the antennal scape, mandibles, anterior legs, including most of their coxæ; trochanters, tip of femora and basal half of hind tarsi dull fulvous-yellow; palpi, tegulæ and four posterior tarsi whitish yellow. Wings subhyaline; stigma black; veins piceous, lighter brown toward the base of the wing. Head transverse, twice as broad as thick, and very short behind the eyes; finely confluent punctate on the vertex, transversely rugulose on the front and face; head behind and cheeks smooth, scarcely punctulate. Eyes oval, thickly clothed with pale pubescence, nearly twice as long as broad; malar space half the width of the eye. Ocelli in a small triangle, the posterior ones closer to one another than to the eye margin. Antennæ in a deep depression; 19-jointed, the scape subcylindrical, curved, as long as the first two flagellar joints together; first flagellar joint nearly three times as long as thick, the following becoming gradually shorter and thinner, the subapical one quadrate. Clypeus separated from the face by a sharp suture, with a foveate puncture near each side; arcuately rounded on its anterior margin; palpi normal, pale yellowish. Mesonotum and scutellum rugose-punctate, the parapsidal furrows and a scutellar margin more or less distinctly indicated by a series of larger, more regular punctate impressions. Scutellum, aside from its basal strip, nearly triangular. The basal strip sculptured across its entire extent by a series of large squarish foveate impressions. Metanotum short, declivous, rugose reticulate with several somewhat irregular areas behind. Abdominal carapace oval, rather coarsely rugose anter-

very finely so posteriorly; rounded behind. The apical opening twice as broad as high. Pleurae rugose-reticulate, more coarsely so behind. Legs very stout, especially the hind pair. Stigma broadly oval, over half as broad as long, emitting the radius just beyond its middle; parastigma distinct, fuscous. Radial cell short, the postmarginal vein no longer than the stigma; length of first, second and third sections of the radial vein in the proportions of 2, 3 and 7. Submedian cell longer than the median by the length of the first section of the radius; recurrent nervure interstitial with the first transverse cubitus which it equals in length; discoidal vein broken near its lower end.

Natal, Brazil. One specimen collected by Mr. W. M. Mann. This is the first South American species to be described.

There are two other specimens, somewhat smaller and with darker legs, from Independencia, which may possibly represent another species, but structurally, there are only slight differences.

***Phanerotoma trivittata* sp. nov.**

Male. Length 5 mm. Buff-colored, the abdomen paler, almost cream-colored; head above and hind femora yellowish; first joint of antenna fuscous, the flagellum pale ochraceous yellow. Marked with black as follows; tips of mandibles, a dumb-bell shaped spot between the ocelli; an elongate spot on the mesonotum anteriorly, a longitudinal stripe on the parapsides; scutellum; spot on mesopleura below base of wing; spot before tip of all femora; anterior and middle tibiae, except base; extreme base and apical third of posterior tibiae. Wings yellowish at base with yellow veins and stigma; apically subhyaline, with fuscous veins, stigma slightly mottled with fuscous. Head one half broader than thick, arcuately rounded behind the prominent eyes; vertex finely rugose, the ocelli close together, the hind ones five times as far from the eye as from one another. Front just above the antennae with a margined depression which includes the anterior ocellus and bears a fine raised median line that extends halfway down the face; face finely rugose. Antennae 23-jointed, tapering; as long as the body; scape almost cylindrical, as long as the first flagellar joint which is four times as long as thick; following gradually growing shorter, at middle of antenna three times as long as thick. Eyes bare, cheeks with an indistinct malar groove half as long as the diameter of the eye. Head behind finely punctulate. Mesonotum faintly rugulose, with feebly impressed parapsidal furrows. Scutellum triangular, longitudinally rugulose, the thoracic dorsum longitudinally striated on each side of the scutellum. Metanotum rugulose, exareolated, the upper hind angles produced into short blunt teeth. Abdomen as long as the thorax; three segmented, the third segment longest; first a little shorter and second still shorter; its upper surface longitudinally rugose-aciculate, less distinctly so on the third segment; first segment with a carina arising at the anterior angle, slanting toward the median line and fading out at the middle of the segment. Apex of abdomen rounded. Pleurae faintly roughened. Hind legs much thickened, others slender. Wings

with the submedian cell longer than the median; subdiscoidal vein arising near the lower angle of the second discoidal cell; recurrent nervure inserted near the base of the second cubital cell; second section of the radius a little longer than the first; second transverse cubital half as long as the first.

Manaos, Brazil (Mann and Baker).

This species is very distinct on account of the disposition of its peculiar pale color and sharp black maculation.

Subfamily CENOCELINEÆ

*Cenocellus tricolor* sp. nov.

Female. Length 9 mm., ovipositor 7 mm. Head above the level of the antennæ, spot above hind coxa, four posterior legs and abdomen above, except on the sides, black; remainder of head and thorax honey-yellow except the metanotum behind which is whitish, and also the anterior legs, except most of the femora and the apical tarsal joint. The abdomen is maculate with yellowish white as follows: hind angles of petiole; a band along each side of segments 3-7 which extends inward half way to the median line along the sutures; these incisures narrow and pointed except at the base of the third segment where they form a broad, widely interrupted transverse basal band. Sides of abdomen whitish; ventral plates black. Wings blackish with a hyaline streak crossing at the insertion of the recurrent nervure. Head twice as broad as thick, arcuately emarginate on the occiput; vertex with a deep median depression extending down the front to the base of the antennæ. The median ocellus lies at the bottom of the depression and the lateral ones on the edge, a carina extending downward from each to the level of the antenna; sides of front and face sparsely punctate; middle of face confluent so; clypeus punctate like the face. Eyes small, rounded oval, as long as the malar space. Posterior edge of head with a high raised margin. Antennæ 32-jointed; scape cylindrical, three times as long as thick; first flagellar joint slightly longer than the second which is three times as long as thick; joints near the middle twice as long as thick. Mesonotum with coarse punctate parapsidal furrows, the middle lobe prominent, twice as long as the lateral ones and prolonged backward between the convergent furrows as a raised line. Scutellum with a broad impressed line at the base composed of four large foveæ. Metathorax above irregularly reticulate; behind and on the sides rugose reticulate. Propleura sparsely punctate; mesopleura smooth with a crenulate mesoepisternal furrow, a carinate posterior margin and several foveæ above. Abdomen polished; first segment one-third as broad at base as at apex, longer than the width at apex (exclusive of the white corners); with a number of curved carinæ on each side of a median smooth space, the median pair of carinæ attaining the base and the lateral pair the apex of the segment; second segment more closely striated except around the edges and on a median stripe which is smooth and slightly elevated into an obsolete tubercle anteriorly; following segments smooth and highly polished. Legs

thickly hairy on the tibiae and tarsi, sparsely so elsewhere. Stigma black; first section of radius one-half longer than the second; second section of radius one-half longer than the first; third section of radius one-third the length of the third; second cubital cell narrowed to its tip one-half as high as its base; recurrent nervure received at the apex of the first cubital cell; submedian cell longer than the median; discoidal vein arising from the apex of the discoidal vein, the second discoidal cell narrowly open at this point; first section of cubitus straight; median cell in hind wing two-thirds as long as the median.

One female from Camp No. 28, Madeira-Mamoré R. R. Co., Rio Madeira, Brazil (Mann and Baker).

This species will be easily recognized on account of its striking color.

#### Subfamily BRACONINÆ

##### *Binarea calida* sp. nov.

Female. Length 13 mm., ovipositor 11 mm. Black, ferruginous and fulvous; wings yellowish with fuscous tip and a median transverse piceous band. Black as follows; head, antennæ, prothorax except hind part of pleuræ; mesosternum and large blotch on mesopleura; hind legs with coxæ, spot on hind femora above at base, knees, stripe on outer side of tibiae and entire tarsi; apical joint of fore and middle tarsi; abdomen beyond third segment (the fourth fuscous) and ovipositor. Thorax otherwise ferruginous, and the legs and abdomen fulvous. Wings with the venation pale fuscous on the clear parts, black elsewhere; stigma black, rufous below apically. Wing tip fuscous from just beyond the second transverse cubitus, the dark cross-band embracing the basal half of the first cubital cell and the apical half of the first discoidal; fore wing also with a hyaline spot in the radial cell and a large one behind the second cubital cell. Hind wing fuscous beyond the base of the radial cell. Head one-fourth broader than long, entirely smooth above; face irregularly rugose, slightly elevated into an indistinct tubercle medially which is more finely rugose; just below each antennal tubercle a short deep groove meets the one of the opposite side to continue upwards between the antennal tubercles. Malar space and cheeks sparsely punctate. Eyes nearly round, twice as long as the malar space. Antennæ long and slender, the joints not distinctly separated; scape and pedicel fringed at tip with ferruginous hairs as in *B. spinicollis*. Palpi pale yellow, the lower side of the head clothed with long buff-colored hairs. Pronotum margined in front; medially behind with a short blunt spine or tooth; prothorax below near the middle with a sharper thorn-like tooth on each side and a second conical elevation or tooth on the anterior margin further forward. Prothorax smooth above and on the sides, finely and densely punctate below. Mesonotum with the middle lobe twice as long as the lateral ones, the parapsidal grooves deep, but impressed only anteriorly. Scutellum immargined, with two large deep, quadrate depressions at the base. Metathorax with a median furrow, more distinct anteriorly and with a large, deep impression behind on each side of the middle. Thorax



to the latter as a pair of *raised* lines. Scutellum with a pair of large quadrate depressions at the base separated by a fine median raised line. Mesopleura elevated along its upper edge and near the upper anterior angles, and with an oblique impressed groove (larger behind) below. Metathorax as described in the generic diagnosis, its lateral angles slightly toothed. Abdomen as long as the head and thorax together; first segment but little widened apically, the central raised portion bordered by lateral carinae and with a pair of converging carinae on its disk, on the sides with a carina above the lateral margin; its surface coarsely aciculate except at the base of the median lobe. Second segment with a pair of approximate rounded elevations behind and with a deep moderately oblique groove from each anterior angle which defines a triangular lateral piece. Third segment tuberculate, raised in front on each side of the middle and also at the anterior and posterior angles; following segments smooth. Legs stout; fore tarsi twice as long as their tibiae; hind femora much thickened, less than four times as long as broad. Wings with lanceolate stigma which is black before the origin of the radius, and pale brown beyond; veins dilute fuscous, picuous under the black markings; submedian cell longer than the median by one-third the length of the transverse median vein; recurrent nervure received at the apical sixth of the first cubital cell; discoidal nervure arising at the posterior angle of the second discoidal cell. Hind wing with the submedian cell two-thirds as long as the median; the resurrent nervure distinct.

Four females from Abuná, Rio Madeira, Brazil, collected by Mann and Baker.

*Cervulus nodicornis* (Brullé).

Hist. Nat. Ins. Hyménop. IV, p. 408. (1846) (*Bracon*).

Mr. Mann obtained a female of this species at Baixa Verde, Rio Grande do Norte. It agrees well with Brullé's description, except that it is a trifle smaller (12 mm. ovip. 6.5 mm.) and the vertex is rufous like the rest of the body.

*Bracon paraensis* sp. nov.

Female. Length 4.5 mm., ovipositor 1.4 mm. Honey-yellow or marked with black, paler on the lower parts of the head and abdomen below. The following parts are black: antennae; broad bands on the second, third, fourth and fifth segments, all of equal length and crossing the fifth segment completely but leaving broad pale lateral spaces on the more anterior segments; sixth segment entirely; ovipositor sheaths, apical joint of four fore tarsi; and hind legs beyond the trochanters, although with the knees and tarsal articulations yellowish. Wings deeply infuscated, more strongly so at the base. Head two and one-half times as broad as thick, rapidly narrowed behind the eyes and not excavated behind. Vertex smooth, ocelli equidistant, separated from one another by their own diameter. Front shagreened medially, with a central finely impressed line above the antennae to the ocelli. Antennae

med; scape short, obliquely truncate at tip, less than twice as thick; flagellar joints all about one-half longer than broad, the longer, twice as long as thick. Face smooth, with a slight convexity to the antennae. Clypeus deeply impressed along its upper margin with the lower edge narrowly reflexed. Head behind smooth, coarsely sparsely punctulate. Palpi slender. Eyes four times as long as the ocular space. Mesonotum not noticeably trilobed; parapsidal furrows distinct, complete, scarcely convergent posteriorly; its surface smooth and shining. Scutellum nearly flat anteriorly, with a transverse carinate furrow across the base. Metanotum with a very much abbreviated median carina posteriorly which is continued in front as a very finely impressed line. Plicurae shining; mesopleura with a small median circular impression. Metaplicura with a deep horizontal sulcus just below the small circular spiracle. Abdomen short, ovate. First segment with a pair of divergent grooves that define a triangular elevation medially on the segment behind. Second segment with a pair of small oval, very deep and sharply defined impressions anteriorly near the median line and also on each side with a much more feebly impressed and irregular longitudinal depression. Third segment on each side basally with a somewhat oblique transverse impression that does not reach the lateral margin however; fourth and fifth segments with similar transverse impressed grooves at the middle of the segment, these are not oblique and reach the sides of the abdomen, simulating additional intersegmental sutures. Legs slender, sparsely clothed with pale testaceous hairs as is the entire body in an irregular way. Wings with the stigma lanceolate, black, as are also the veins. First section of the radius as long as the width of the stigma; second segment twice as long; second cubital cell with parallel upper and under sides, the first transverse cubitus very oblique and the second vertical; recurrent nervure received just before the tip of the first cubital cell.

One female collected by Mr. Wm. M. Mann at Pará, Brazil.

In general appearance this is very much like the nearctic *Microbracon mellitor* and its allies, but the sculpture of the abdomen is of an entirely different type.

#### *Iphiaulax xanthothorax* Brullé.

Hist. Nat. Ins. Hyménop., Vol. IV, p. 308 (1840). (*Bracon*).

There is a female from Porto Velho, Rio Madeira, Brazil, which agrees well with Brullé's description. The specific name is evidently intended to be *xanthothorax*, but the spelling given above appears in the original.

#### *Bracon crassitarsis* sp. nov.

Female. Length 10-11 mm.; ovipositor 7-7.3 mm. Pale ferruginous with head, most of legs and abdomen beyond fifth segment, black; wings blackish, yellow at base. The black is as follows; head except base of mandibles and tip of last palpal joint; antennae; prothorax, except upper hind angles; metathorax; fifth abdominal segment (some-

times in part); all following segments; ovipositor and its sheath; legs, except anterior knees and four basal joints of anterior tarsus; the middle tarsi brownish on first four joints. The wings have the stigma black and are strongly infuscated beyond the basal vein, though pale yellowish toward the base. Head nearly twice as wide as thick, rounded and narrowed behind the eyes. Front above the antennae with a deep depression that is divided by a fine, sharp median carina; antennal tubercles rather short. Face finely rugose, faintly reticulate, with a vertical raised line extending from each antennal tubercle to the clypeus and a second near to the eye. Clypeus crescentic, margined above by a fine line and fringed below with a brush of porrect pale yellow hairs. Eyes large, oval, fully five times as long as the malar space. Antennae a little shorter than the body; scape as long as the width of the eye, broadened apically; first flagellar joint nearly twice as long as wide; second not quite half longer than wide; following nearly quadrate. Mesonotum with the parapsidal furrows impressed anteriorly, convergent. Scutellum with a smooth impressed line across the base. Metathorax smooth and polished; sparsely punctulate on the sides. Abdomen elongate, as long as the head and thorax, and but little wider; raised median portion of first segment narrowed in front, but attaining the base of the segment; close to it on each side is a carina. Second segment with a small median tubercle in front, on each side of which is a foveate depression, without lateral carinae or separated corners; its suture with the simple third segment smooth. Third segment the longest, nearly half as long as broad. Mesopleura with the femoral furrow narrow; the metapleural depression rather deep and lying just outside the elongate reniform spiracle. Legs stout, the tarsi much shortened and flattened, especially those of the middle and fore legs; clothed with sparse, glistening pale hairs, denser on the tibiae and black on the hind ones. Wings with the stigma lanceolate; submedian cell as long as the median; first section of cubitus strongly curved so that its base runs nearly parallel for a short distance, its origin being at the upper third of the basal vein; recurrent nervure received at the apical fifth of the first cubital cell; first section of radius one-third as long as the second and two-thirds as long as the first transverse cubitus; second transverse cubitus slightly oblique, with a hyaline spot near its top and bottom; discoidal vein broken at its lower third.

Male. Length 9 mm. In this sex the anterior tibiae are almost entirely fulvous; the second trochanters of the fore and middle legs are ferruginous and the first four joints of the middle tarsi are yellowish. The tarsi are not thickened and their pile is dark, except on the anterior pair. Palpi entirely pale. The black on the fifth abdominal segment is also more extensive, covering the surface except on the sides and the posterior edge.

Five specimens, four females and one male from Rio Madeira, Brazil (Camp 39, Madeira-Mamoré R. R.) Mann and Baker.

This is a very distinct species on account of the peculiar form of the tarsi in the female and the conspicuous color pattern.

***Bracon thalessiformis* sp. nov.**

male. Length 18 mm.; ovipositor 55 mm. Black, with most of thorax and the first segment of the abdomen pale ferruginous. Blackish, with a pale band before and another after the middle. Ferruginous thorax has the prothorax black, except on its posterior and the metathorax is blackish medially, in addition to a triangular spot on each side before the hind coxa. The second abdominal segment is tinged with brown and ferruginous along the sides and the ventral surface is colored almost as the dorsal aspect. The fore wing is black at the base, becoming paler to the end of the submedian cell, when it is black to the base of the radial cell, then pale through most of the second cubital and finally blackish beyond to the tip. The hind wing is blackish, with an incomplete pale band at the middle. Head scarcely wider than thick, sharply excavated behind at the middle of the occiput, the face receding so that it is almost horizontal. Eyes small, round, removed by their own diameter from the base of the mandibles; surface smooth and polished above and behind, sparsely punctulate on the cheeks. Face subshining, closely punctulate except for a small, nearly smooth, central portion; clypeus shining, with a complete, fine, sharply raised margin. Front with a shallow depressed space including the ocelli; antennal tubercles rather small. Antennae as long as the body; scape cylindrical, elongate, nearly as long as the thickness of the head; first flagellar joint twice as long as thick; second one-half shorter; remainder nearly quadrate. Palpi long, very slender, the last joint yellowish at tip. Prothorax smooth and shining. Mesonotum without parapsidal furrows, although the median portion is somewhat produced anteriorly. Scutellum with a narrow, smooth groove separating it at the base from the mesonotum. Metathorax without carinae, polished, smooth except for small very sparse punctures on the sides. Abdomen long and narrow, no wider than the thorax. First segment one-half wider at apex than at base, its median elevation ovate, pointed anteriorly, on each side of this with two smooth grooves separated by a carina before the raised margin; second segment one-half longer than broad; smooth, except that the anterior corners and the lateral margins are separated by a smooth groove from the central portion; third segment about quadrate, the anterior angles very indistinctly separated, following segments growing shorter; hypopygium longer than the pygidium. Pleurae smooth, with a deep femoral groove extending from the fore coxa to the root of the hind wing and a less pronounced groove just external to the oval metathoracic spiracle. Legs long and rather slender, with the hind femora clavate. Wings with the submedian cell indistinctly longer than the median, recurrent nervure interstitial with the first transverse cubitus; first section of the radius one-fifth as long as the second and half as long as either of the transverse cubiti; second transverse cubitus with its lower half perpendicular, but strongly bent toward the wing tip above; discoidal vein broken at its lower two-fifths. Stigma black, fulvous on its lower half.

One female from Rio Madeira, Brazil (Madeira-Moreira R. R. Co., Camp 39), collected by Mann and Baker.

This is a very remarkable species on account of the long ovipositor, although several others are known in which this organ attains a similarly great length.

#### *Iphiaulax* Förster.

Of this genus, so richly represented in the neotropical fauna, a considerable number of species were obtained, at least five of which are undoubtedly undescribed. These may be separated as follows:

1. Wings dark at apex..... 2  
Wings with dark cross-band, but the anterior ones white at apex. *I. reduvioides*
  2. Wings with distinct dark cross band before apex..... 4  
Wings without distinct dark cross-band before the dark apical portion; legs in part pale..... 3
  3. Face with a median furrow or depression, abdomen rather narrow; length 12 mm..... *I. fortis*  
Face not excavated medially; abdomen rather broad, length 7.5 mm. *I. starksi*
  4. Legs entirely black abdomen broad; ovipositor shorter than abdomen..... *I. carapuna*  
*I. abunensis*
- Legs in great part pale; abdomen slender; ovipositor longer than the body.

#### *Iphiaulax reduvioides* sp. nov.

Female. Length 11 mm.; ovipositor 5 mm. Black, with the first abdominal segment except the apical portion of the central elevation, the sides of the second and third, extending inwardly somewhat along sutures, and the extreme lateral edge of the fourth, rufous. Tips of maxillary palpi yellow. Wings pale brown at the base nearly to the basal vein, then with a black band which includes over half of the second cubital cell, and apically white. Basal third of stigma bright fulvous, the color extending somewhat into the upper part of the first cubital cell; third discoidal cell with a hyaline spot basally above, hind wing black on apical half, basally pale brown. Venter fulvous on second, third and fourth segments, black beyond. Antennae as long as the body and ovipositor together, head one half broader than thick, obliquely narrowed behind the eyes; ocelli surrounded by a grooved line; face finely rugulose punctate, slightly convex, with a faint, fine median carina, and an indistinct grooved line on each side near the eye-margin; front and vertex shining, impunctate, the former extending between the antennal tubercles as a polished median groove, malar space very short. Mesonotum highly polished, the parapsidal furrows smooth, but slightly convergent and obsolete behind. Scutellum smooth, with a line of large confluent punctures at the base. Metathorax without carinae, smooth medially, punctulate laterally. Abdomen broadly oval, much wider than the thorax, the first segment quadrate, not narrowed basally, the swollen pleural portions visible from above on each side, as wide as the segment and blackish-yellow in color; median elevation narrowed

rounded basally, separated from the lateral carinae by a broad, shallow groove. Second segment four times as broad as long, the apical field narrow, much attenuated behind. Third segment without a line or carina, the lateral angles separated by deep grooves; the third longer than the second medially and much shorter laterally, enclosing the produced lateral angles. Third and fourth segments separated by a transverse groove, the third with the lateral angles separated. Ovipositor fuscous, its sheaths black. Wings with the venation fuscous basally, black at the middle, and pale brown on the hyaline apical portion; second cubital cell half as long as the marginal, nearly one half longer below than above; recurrent nervure received almost at the apex of the first cubital cell, parallel with the first transverse cubitus.

One female from Abuná, Rio Madeira, Brazil, Mann and Baker.

This is a stout, heavy-set species with quite conspicuously pilose shining body and densely hairy legs.

It resembles most closely two neotropical species, *I. tristis* and *I. semialbus* recently described by Szépligeti (Termes. Füzetek., Vol. 24, p. 397, (1901)), but may be easily distinguished from the first by the form of the first abdominal segment and the wing pattern, and from the second by the absence of a carina on the third segment and the different color of the wings. It is a very striking form, reminding one of a Reduviid bug in shape.

*Iphiaulax fortis* sp. nov.

Female. Length 12 mm., ovipositor 9 mm. Black, palpi pale; first four abdominal segments and base of the fifth ferruginous; coxae and femora, except base of four anterior ones, hind tarsi, and hind tibiae except bare inner edge, black; remainder of legs honey-yellow, except upper side of trochanters. Wings pale brownish-yellow, infuscated at tips. A rather slender species, with the abdomen elongate, the head distinctly broader than thick and rounded off behind the eyes. Face confluent punctate, with the median depression between the low antennal tubercles extending down to the finely punctate, margined clypeus. Eyes oval, four times as long as the malar space. Antennae slightly longer than the body; scape twice as long as thick; first flagellar joint distinctly longer than the second; following about quadrate. Parapsidal furrows distinct anteriorly; scutellum with a line of square punctures across its base. Metanotum punctulate on the sides, thinly clothed with thin pale hairs, the lateral groove nearly divided by the oval spiracle. Abdomen sparsely and coarsely punctate except at base and apex. First abdominal segment with its median elevated portion somewhat narrowed and rounded anteriorly, but little narrowed behind, separated from the lateral carina by a coarsely crenulate groove; the segment about as long as broad behind. Second segment rugose-

punctate, the middle field smooth, triangular, short, but prolonged behind as a narrow elevation; on each side with a deep, oblique impression reaching to the posterior angles. Second suture straight medially, curved forward laterally, very broad, crenulate or striate, the anterior angles separated by a lateral, nearly transverse, crenulate groove. Third segment with separated anterior angles and a deep crenulate transverse groove near the base; fourth and fifth segments sinuately sculptured, and the sixth obsoletely so. Legs slender. Wings with black stigma; first section of radius one-third as long as the second, and two-thirds as long as the first transverse cubitus; second transverse cubitus with a hyaline spot below, slanted outwards above; cubitus not very strongly curved at base; submedian cell as long as the median; recurrent nervure received just before the apex of the first cubital cell; discoidal vein broken a little below the middle.

One female from Camp 39, Madeira-Mamoré R. R., Rio Madeira, Brazil (Mann and Baker).

This does not seem to be very closely related to any other species of similar color.

*Iphiaulax starksi* sp. nov.

Female. Length 7.5 mm., ovipositor 3 mm. Black, the scutellum and metanotum rufous, first four segments of abdomen, sides and base of fifth, fulvous; four anterior legs beyond the knees, and a stripe on the outer edge of hind tibiae yellowish; ovipositor fuscous. Wings yellowish hyaline, slightly darkened below the black stigma and infuscated beyond the base of the third cubital cell, veins all fuscous. Head one-third broader than thick, obliquely rounded behind the eyes. Face flattened, finely rugulose, the clypeus with a sharp, raised marginal line. Palpi pale. Antennae nearly as long as the body; scape almost three times as long as thick; first flagellar joint longer than the second; following quadrate. Mesonotum with the parapsidal furrows distinct anteriorly; scutellum with a crenulate line across the base. Metathorax scarcely punctulate laterally, its spiracles round. Abdomen rather broad. First segment at apex nearly twice as broad as at base, its median elevation oval, much narrowed basally and separated from the lateral carina by a rugose groove. Second segment with a short, broad basal median elevation which is prolonged to the apex as a carina; on each side with a deep oblique depression that marks off the anterior angles, but does not attain the posterior margin. Second suture broad, striate, straight medially and curved forward laterally as the separated angles of the third segment are produced forward; second to fourth segments sparsely, deeply and coarsely punctate. Legs slender. Wings with the first section of the radius nearly one-third as long as the second and two-thirds as long as the first transverse cubitus; second transverse cubitus nearly perpendicular, with a hyaline dot above and below, cubitus bent at the base; recurrent nervure received well before the tip of the first cubital cell; discoidal vein broken a short distance below the middle; submedian cell as long as the median.

One female from Pará, Brazil (Wm. M. Mann) named after P. Starks, a member of the expedition.

This species falls near two Brazilian species, *I. hirtulus* and *I. conflavus* described by Szépligeti, but differs by its much longer ovipositor and different abdominal sculpture.

***Iphiaulax carapuna* sp. nov.**

Female. Length 9.5 mm.; ovipositor 3 mm. Black, with the apical two joints of the palpi pale yellow and the first four, and base of the fifth abdominal segments bright ferruginous. Wings with a black transverse band beginning at the origin of the basal vein and extending into the base of the radial cell, beyond this infuscated and basally pale yellowish; stigma wholly black; hind wings pale yellowish at base, infuscated on apical half. Head one-half wider than thick, obliquely narrowed behind the eyes. Front impressed on each side above the antennae and with a median carina that extends down between the short antennal tubercles. Face irregularly rugulose, the small clypeus distinguishable as a smooth spot; malar space short, one-fourth as long as the large, oval eye. Prothorax smooth on the sides, distinctly punctate medially. Mesonotum with smooth, parallel parapsidal furrows that extend to the posterior third. Scutellum convex, with a smooth impressed line across its base. Metanotum evenly rounded, without carinae; punctulate on the sides. Mesopleura with a deep, oblique femoral furrow; and metapleura with a groove just external to the rounded-oval spiracles. Abdomen one-half broader than the thorax; first segment with an oval elevated portion that is rounded in front. On its sides is a pair of parallel smooth grooves, each separated from a second lateral smooth groove by a strong carina. Second segment with the middle field triangular, reaching beyond the middle of the segment and continued for a short distance as a raised line; sides and anterior angles separated by a very deep depression. Third segment with the basal suture strongly bisinuate and crenulate; the anterior angles separated by very deep impressions; with a triangular middle field that reaches nearly to the middle. Fourth segment with the anterior corners separated and with a transverse groove near the center. This groove is repeated on the fifth segment, and less distinctly on the sixth. Hypopygium shorter than the pygidium. Legs short, stout, and densely hairy, especially the hind pair. Wings with the submedian cell barely longer than the median; recurrent nervure received at the tip of the first cubital cell; first section of radius one-third as long as the second and two-thirds as long as the first transverse cubitus; second transverse cubitus straight, perpendicular; discoidal vein broken at its lower third. Stigma narrowly triangular.

One female, Rio Madeira Brazil (Camp No. 39, Madeira-Mamoré R. R.) (Mann and Baker).

This species resembles *I. polybothris* Brullé, but differs structurally as well as in color.



*Iphiaulax abunensis* sp. nov.

Female. Length 11.5 mm.; ovipositor 14 mm. Fulvous; the head, except for the pale palpi and the red tip of scape and underside of prothorax, except posterior angles; abdomen above, beyond the base of the fifth segment; ovipositor and its sheaths, all coxae, middle and fore femora, middle femora, except base and apex, hind femora apical half of tibiae, their tarsi, and apical joint of four anterior tarsi black. Fore wings pale yellowish with an uneven blackish median band and infuscated tips from the base of the third cubital cell; stigma black; hind wings slightly infuscated. Head transverse, not quite half broader than thick; antennae slightly shorter than the body, the scape twice as long as thick; first two flagellar joints subequal, each twice as long as thick. Face sparsely and irregularly punctate on the sides, with a median flat, polished area showing traces of fine aciculations; clypeus finely irregularly punctate; antennal tubercles short. Eyes oval, three times as long as the malar space. Mesonotum with the parapsidal furrows indicated only in front. Scutellum with a crenulate line across its base. Metanotum smooth above, punctulate on the sides, with a deeply impressed groove just outside the elongate oval spiracles. First segment of abdomen, exclusive of its membranous sides, twice as long as wide, the lateral margins parallel; the median elevation ovate, pointed in front, constricted and truncate behind; on each side of this is a deep, narrow, groove before the carinate margin. Second segment nearly as long as wide behind, the median field long and narrow, reaching beyond the apical third of the segment; on each side of this is a broad longitudinal depression, then a carina, then a second similar, but narrower depression that extends to the posterior corner. Second suture rather wide, obsolete crenulate, slightly extended forward at the middle where the apical margin of the second segment is raised. Third segment the widest; twice as broad as long and faintly concave on its posterior margin; the anterior angles not produced forward, but separated as large spaces by a groove that curves across the segment from near the median line to the center of the lateral margin; with an indistinct, narrowly triangular median elevation. Fourth segment with an arcuate groove, interrupted at the median line, across the middle of its base. Legs rather long, not stout, wings with the cubitus strongly bent near the base; recurrent nervure received at the tip of the first cubital cell; first section of the radius one-third as long as the second and two-thirds as long as the slightly oblique second transverse cubitus; submedian cell slightly, but distinctly, longer than the median; discoidal vein broken near its lower third.

One female from Abuná, Rio Madeira, Brazil (Mann and Baker).

This is related to *I. excisus* Szépligeti, but differs by its shorter ovipositor and different abdominal sculpture, the second segment having two pairs of longitudinal grooves, and the fourth having an arcuate line, without lateral curved lines.

## Subfamily RHOGADINÆ

**Rhogas** Nees.

There are two species, both undescribed, in the collection, which brings up the total of Brazilian species to five. These may be distinguished as follows:

1. Recurrent nervure inserted in the first cubital cell..... 2
- Recurrent nervure interstitial or nearly so..... 4
2. Wings of uniform color..... 3
- Wings distinctly bifasciate..... *R. bakeri* sp. nov.
3. Pale yellow, with head, antennæ and four hind legs beyond the knees deep black..... *R. insignipes* sp. nov.
- Yellowish red, with abdomen blackened above; all legs pale beyond the knees..... *R. brasiliensis* Szép.
4. Legs entirely pale, wings distinctly bifasciate..... *R. maculipennis* Szép.
- Hind femora mostly black; wings very indistinctly maculate..... *R. pulchricornis* Szép.

**Rhogas insignipes** sp. nov.

Male. Length 8 mm. Uniformly pale ochre-yellow, very conspicuously and sharply marked with black as follows; entire antennæ and head, except palpi; last joint of fore tarsi; middle legs beyond the basal third of the tibia, and hind legs beyond the extreme base of the tibia. Wings tinged strongly with yellowish-fuscous; veins pale brown; stigma wholly piceous; pale parts of body with pale yellow pubescence; black parts with black. Head somewhat over twice as broad as thick antero-posteriorly, the front occupying only one-fourth the width of the head when seen from above. Face of the same width as the front, transversely rugose aciculate, with a short, sharp keel below the antennæ. Eyes very large, deeply emarginate opposite the antennæ; malar space extremely short, only half as long as one of the middle joints of the antennæ. Ocelli very large, the lateral ones nearly touching the eye-margin, due to the narrowness of the front. Antennæ as long as the body, about 65-jointed, gradually tapering, the joints about quadrate. Head behind the eyes microscopically rugulose. Mesothorax dull, but not punctate, the parapsidal furrows sharply defined but not at all crenulated. Scutellum with a broad, deep, longitudinally fluted and medially divided depression across its base, dull like the mesonotum; post-scutellum paler and polished. Metathorax with the median and lateral carina complete, though delicate, the former bifurcating behind to form a very small petiolar area; surface of metanotum faintly roughened. Pleuræ smooth and polished. Abdomen with the median carina distinct on the first two segments, but without any distinct longitudinal aciculation; first segment one half longer than wide at tip; base two-thirds as wide as tip; second segment slightly transverse; following becoming more strongly so. Legs moderately slender. Wings ample; stigma lanceolate, omitting the radius at its middle; first section of radius two-thirds as long as the second; recurrent nervure received at half its own length before the tip of the first cubital cell; transverse median nervure entering the first discoidal cell before the middle.

One specimen from Independencia, Parahyba, Brazil (Mann and Heath).

The conspicuously blackened legs of this species render it very conspicuous and easily recognizable.

***Rhogas bakeri* sp. nov.**

Female. Length 6 mm. Very pale luteous, with the sterniticum black, and the hind femora, tip of their tibiae and tips of all tarsi slightly infuscated. Wings pale yellow, with a basal cross-broad of fuscous which is more or less separated into two spots, one on the basal vein and the other below the apical part of the submedian cell. Veins and stigma pale luteous, fuscous along the clouded parts of the wing. Head twice as broad as thick antero-posteriorly, the narrowest part of the front one-third as broad as the head, face faintly rugulose, with a short carina below the antennae. Antennae (broken at tips) probably about 40-jointed, the joints quadrate. Eyes large, emarginate opposite the antennae, but not very deeply so; malar space as long as the basal joint of the antennal flagellum. Ocelli large, the posterior ones as far from the eye-margin as from one another. Head punctulate behind the eyes. Mesonotum dull, with the parapsidal furrows present, but very weakly impressed. Scutellum with the basal impression coarsely striated, not divided by a median carina. Metanotum rugulose, with a median and lateral carinae, weakly elevated. Pleurae impunctate, the mesopleura larger and extending farther downward than usual. Abdomen with the median carina extending to the middle of the third segment; first and second segments very faintly longitudinally aciculated; first segment one-third longer than broad at tip, its base two-thirds as wide as the tip; second segment slightly longer than broad; third transverse, following much shorter, ovipositor nearly one-third as long as the second abdominal segment. Legs stout, the femora thickened, especially those of the hind pair. Wings with the stigma rather broad, its width nearly equal to the length of the first section of the radius which is fully as long as the second; recurrent nervure received more than half its own length before the tip of the first cubital cell; second cubital cell almost as high at apex as at base, the second transverse cubitus hyaline except at the corners of the cell; transverse median vein entering the first discoidal at its middle.

One female from Rio Madeira (Camp No. 39, Madeira-Mamoré R. R.) Brazil, Mann and Baker.

This is a rather anomalous species, showing somewhat of a transition to *Heterogamus* in the length of the first section of the radial vein. It is quite similar to the West Indian, *R. bifasciatus* Ashm., but the abdominal carina extends beyond the first segment.

**Eucystomastax** gen. nov.

Related to *Cystomastax* Szépligeti which it resembles in the peculiarly dilated palpi, but differing in the broadly sessile abdomen, longer median cell, smaller eyes, round metathoracic spiracles, etc.

Resembling *Rhogas* in general habitus. Head transverse, narrowed behind the eyes; margined behind. Malar space as long as the mandible; clypeus moderately emarginate opposite the antennae. Maxillary palpi flattened, with the first to third joints greatly swollen, but not flattened; labial palpi 3-jointed, first joint thickened, but cylindrical. Clypeus sharply projecting, with a porrect mystax of stiff black hairs. Ocelli moderately large and close together. Antennae setaceous, a little longer than the body. Thorax with the parapsidal furrows deep anteriorly, but abbreviated behind. Metathorax with a complete median and lateral carinae; its spiracles rather small, round; mesopleural suture complete, crenulated. Abdomen with a strong median carina on the first two segments; a little longer than the head and thorax; coarsely longitudinally aciculated on the first, second and base of third segment; first segment one-third longer than the second, less than twice as long as broad at tip; second segment slightly transverse; third twice as broad as long; fourth to seventh strongly transverse; all the sutures very deeply impressed. Legs long, rather slender, densely hairy. Wing with the marginal cell nearly reaching to the tip, stigma lanceolate, radius originating just before its middle; first section of radius one-third as long as the second; second transverse cubitus not swollen; not so stout as the other veins; recurrent nervure at the apical fourth of the first cubital cell; transverse median vein inserted beyond the basal third of the first discoidal cell; discoidal vein broken far below the middle. Hind wing with the submedian cell half as long as the median.

Type. *E. bicolor* sp. nov.

This genus may be separated from the related genera of Rhogadiniæ having dilated palpi as follows:

1. Palpi with the joints in part flattened, leaf-like ..... 2  
Palpi with the joints swollen, but not flattened..... 3
2. Second section of radius twice as long as the first; upper and lower sides of second cubital cell parallel ..... *Microctonus* Szep.  
Second section of radius less than twice as long as the first; second cubital cell distinctly narrowed toward its tip ..... *Pelecystoma* Wesm.
3. Metathoracic spiracles round; abdomen sessile ... *Eucystomastax* gen. nov.  
Metathoracic spiracles slit-like; abdomen petiolate ... *Cystomastax* Szep.

**Eucystomastax bicolor** sp. nov.

Male. Length 9.5 mm. Black, with the base of the mandibles, fore coxae, and entire thorax except tip of metathorax, orange-yellow. Head twice as broad as thick, strongly convex below the antennae; the face with a short median carina just below the antennae; front smooth and shining, slightly concave; vertex and cheeks smooth; hind head punctulate; face smooth below on sides; elsewhere microscopically rugulose-punctulate. Mandibles with the upper tooth twice as large as

the lower one. Antennæ 68-jointed, slender, longer than the body; the flagellar joints all about twice as long as thick; the first three segments; scape oval, twice as long as thick. Prothorax smooth and shining, deeply impressed across each side. Mesonotum smooth, slightly elevated, especially the middle lobe in front; the parapsidal furrows not sharp, but more or less indicated in front by broad impressions. Scutellum triangular, margined only at the sides of the basal impression; its disc with a few large punctures. Metanotum smooth medially in front, on the sides punctate and behind irregularly rugose. Metapleuræ smooth, with a few punctures only on the metapleuræ. Abdomen highly polished, smooth beyond the base of the third segment. Legs long and thickly hairy on the tibiæ and tarsi. Wings deeply infuscated, nearly black, but with very little violaceous reflection; veins black, piceous beyond the cross-veins.

One male. Pará, Brazil. Mr. Wm. M. Mann.

This is a very conspicuous species on account of its brightly contrasting thorax, black wings and polished body.

#### Subfamily SPATHIINÆ

##### *Heterospilus fasciiventris* sp. nov.

Female. Length 2.2 mm.; ovipositor 0.7 mm. Mesos- and metathorax, first segment and posterior third of second segment of abdomen black; head dilute piceous, black above. Scape, base of antennæ, ovipositor and legs pale yellow. Abdomen, except for the black markings, pale honey-yellow. Extreme tips of tarsi and ovipositor black. Head twice as broad as thick, moderately narrowed behind the eyes and somewhat excavated behind; strongly margined behind. Vertex shining; feebly, but distinctly transversely aciculate; with a circular impression to the side of each posterior ocellus, the two narrowly connected above the ocelli; posterior ocelli nearly as far from each other as from the eye margin; front slightly concave, weakly transversely aciculate, the lateral margin slightly carinate just above the antennæ. Antennæ long and slender, basal flagellar joint six times as long as thick; the joints near the middle of the flagellum four times as long as thick. Face honey-yellow, rugulose, clypeus honey-yellow, very convex. Mesonotum shagreened, with deep, convergent crenulate parapsidal furrows; middle lobe aciculate behind as in the following species. Scutellum shagreened, with a broad, deep longitudinally fluted groove across its base. Metathorax partly areolated: its upper face with a lateral carina, and the sides of a posterior carina, enclosing a large rugulose area which is angularly excavated behind by a large diamond-shaped supero-median area that is open behind at the apex of the metathorax and closed near the base; surface except on the basal area coarsely rugose-reticulate. Pro- and mesopleuræ shagreened, the former with a deep, oblique groove, the latter with a deep groove along its lower margin, several oblique foveate impressions at its anterior angle and with a crenate line along its posterior edge. Metanotum rugose-reticulate, with a minute thorn-like projection just above the middle

Abdomen as long as the head and thorax together; ovate; first segment twice as long as broad at tip, with a somewhat median space bounded by carinae converging from the anterior angles, but not very clearly differentiated from the irregular longitudinal pliculations which cover the segment. Second segment nearly as long as broad at tip; aciculated on its basal two-thirds; crossed just before the middle by a crenulate impressed line, and at its posterior third by a broad, shallow groove; third to sixth segments smooth and shining. Legs scarcely thickened, sparsely beset with pale hairs. Wings subhyaline; stigma and veins dilute fuscous; the former, very narrowly triangular, emitting the radius somewhat before the middle; first section of radius two-thirds as long as the second; cubitus arising a little above the middle of the basal vein; first transverse cubitus wanting, second weak, but distinct; submedian cell a little longer than the median, the transverse median vein very short, almost punctiform; subdiscoidal vein interstitial, the second discoidal cell wide open.

One female from Ceará-Mirim, Rio Grande do Norte, Brazil. (Wm. M. Mann).

This species is much more slender and structurally quite different from the following, and when these small Braconidae are better known the two will probably fall into different genera.

*Heterospilus meridionalis* sp. nov.

Female. Length 2.6 mm.; ovipositor 1.5 mm. Black; apical half of antennae and abdomen beyond the second segment piccous; scape and base of antennal flagellum castaneous; palpi whitish; coxae pale yellow; tegulae and legs dull brownish yellow. Wings slightly infuscated, with dark brown stigma and veins. Head shagreened above, rugulose on the face; barely twice as wide as thick and sharply narrowed behind the eyes; with a strong margin behind. Front concave above the antennae, but not deeply impressed; ocelli in a triangle with its shortest side above, the posterior ones nearly twice as far from the eye as from one another. Face evenly convex, piccous, with a small raised smooth spot below the antennae; clypeus dull yellow, semicircular, with the arcuate upper margin indicated by a fine raised line. Cheeks smooth and polished, malar space about one-third as long as the nearly circular eye. Antennae 25-jointed, very slender; scape subcylindrical, twice as long as thick; pedicel quadrate; first flagellar joint four times as long as thick; following gradually shortening, those near the middle of the flagellum three times as broad as thick. Thorax finely shagreened, with a faint aeneous tinge; parapsidal furrows deep and crenulate; middle lobe of mesonotum with three short, deep longitudinal grooves before the base of the scutellum. Scutellum with a broad, deep, longitudinally fluted groove across its base. Metathorax rugose-reticulate, with a rather ill-defined area on each side at the base; these areas much more finely sculptured except around the border. Propleurae

with a broad horizontal, crenulate furrow, rugulose anteriorly, rugose-reticulate behind; mesopleura shagreened, with an crenate groove near the upper anterior angle and a similar one posterior edge. Abdomen as long as the head and thorax downwards and obovate when seen from above; sessile, the first as long as broad at tip, the base somewhat over twice as broad as apex. First and basal two-thirds of second segment longi-aciculate, the striae becoming finer apically; beyond to the apex and shining, with broad rufous margins on the second to fifth segment entirely castaneous. Second segment with a fine impressed line across its middle and traces medially of a second groove just behind this line. Legs slightly thickened on the femora; sparsely pilose with pale hairs. Wings subhyaline, the stigma narrowly triangular, the radius at its center; cubitus arising near the top of the basal vein first transverse cubitus barely discernible, interstitial with the recurrent nervure; second one weak, but distinct; first section of the radius three-fourths as long as the second; submedian cell slightly longer than the median; subdiscoidal vein interstitial, the second discoidal cell widely open. Hind wing with a closed basal cell, but without a radius. Ovipositor as long as the abdomen, fulvous, black at tip; its sheaths piceous.

One female from Ceará-Mirim, Rio Grande do Norte, Brazil, collected by Mr. Wm. M. Mann.

This species approaches *H. nigrescens* Ashm. from the Island of St. Vincent, but has no white ring at the base of the antennae, and the ovipositor is twice as long.

#### *Heterospilus dubitatus* sp. nov.

Female. Length 2 mm., ovipositor 0.6 mm. Piceous, varied with rufous; legs testaceous, wings subhyaline. Antennae with the scape yellow, except at tip; flagellum piceous, fuscous toward the base; palpi whitish; collar, mesonotum and mesopleura black; remainder of thorax rufous; abdomen black beyond the transverse groove on the second segment; rufous basally; ovipositor yellow, with black tip; legs pale testaceous, blackened on the tips of the tarsi.

Resembles *H. meridionalis* very closely in structure, but the antennae are 23-jointed, the triangular area on each side of the metathorax at base is sharply defined, and not at all sculptured, except for a row of punctures around its edge, the first abdominal segment has a very distinct elevated median portion defined by a pair of carinae that converge somewhat from the anterior angles to near the tip of the segment; the second segment bears two complete, approximate transverse furrows near the middle, this segment being considerably longer than wide instead of quadrate, and the first section of the radial vein is fully as long as the second.

One female from Ceará-Mirim, Rio Grande do Norte, Brazil. (W. M. Mann).

The three species of *Heterospilus* here described may be distinguished as follows:

- |    |   |                        |
|----|---|------------------------|
| 1. | segment of abdomen as long as broad at tip; abdomen conspicuously banded with yellow.....   | <i>H. fasciventris</i> |
|    | segment distinctly shorter than broad at tip; abdomen black, more or less rufous at base.....   | 2                      |
| 2. | opositor as long as the abdomen; first section of the radius much shorter than the second; abdomen black.....   | <i>H. meridionalis</i> |
|    | opositor scarcely more than one-half as long as the abdomen; first section of the radius as long as the second; abdomen rufous on the first segment and basal half of the second..... | <i>H. dubitatus</i>    |

#### Family ALYSIDÆ

#### *Idiasta nigripennis* sp. nov.

Male. Length 5.5–6 mm. Black, with the thorax and basal half of the abdomen honey-yellow; wings very strongly infuscated, almost black. Head large, highly polished, a little more than twice as broad as long, not narrowed behind the eyes. Clypeus very small, sharply triangular, closely punctate, face punctulate; front smooth and highly polished with a deep transverse depression above the antennæ and below the ocelli which occupy a small triangle far from the eyes; antennæ long, one-half longer than the body; with fifty joints. The fourth very distinctly longer than the third. Mandibles fuscous, with black teeth, coarsely punctate externally. Palpi very delicate and slender, pale yellow. Eyes almost circular, their diameter equalling the length of the fourth antennal joint. Mesonotum smooth and polished, with deep strongly convergent parapsidal furrows which unite far before the cutellum. Scutellum strongly convex medially in front, straight on its posterior edge, and at the base with a broad deep depression separating it from the mesonotum. This groove is divided on the median line by a fine carina. Pleuræ smooth and shining, the mesopleura deeply impressed just below the wing and with a foveate impression just before the carina which separates it from the metapleura. Metathorax smooth, with a strong median carina that bifurcates behind to form a broad triangular petiolar area; also with a lateral, strongly sinuate carina that curves laterally to go out beyond the moderately small, circular spiracle. Metapleura with a large deep foveate impression just anterior to the spiracle and a smaller one below, near the middle, just behind the anterior margin. Abdomen broadly sessile, peculiarly formed at the base in that the ventral part of the first segment spreads out laterally beyond the dorsal part; seen from above it is exposed behind on each side to a width of nearly one half the dorsal plate. The latter is less than twice as long as broad at the tip which is twice as wide as the base; spiracles at the middle, very prominent, their tips as far apart as the posterior angles; petiole at base with two short, convergent arinæ. Abdomen smooth and shining, but little widened medially and one-half longer than the head and thorax together; black above beyond the second segment. Legs slender, loosely hairy; entirely black, except for yellowish tips to the trochanters, bases to the tibiæ and a fuscous tinge on the tarsi and anterior tibiæ. Wings blackened,



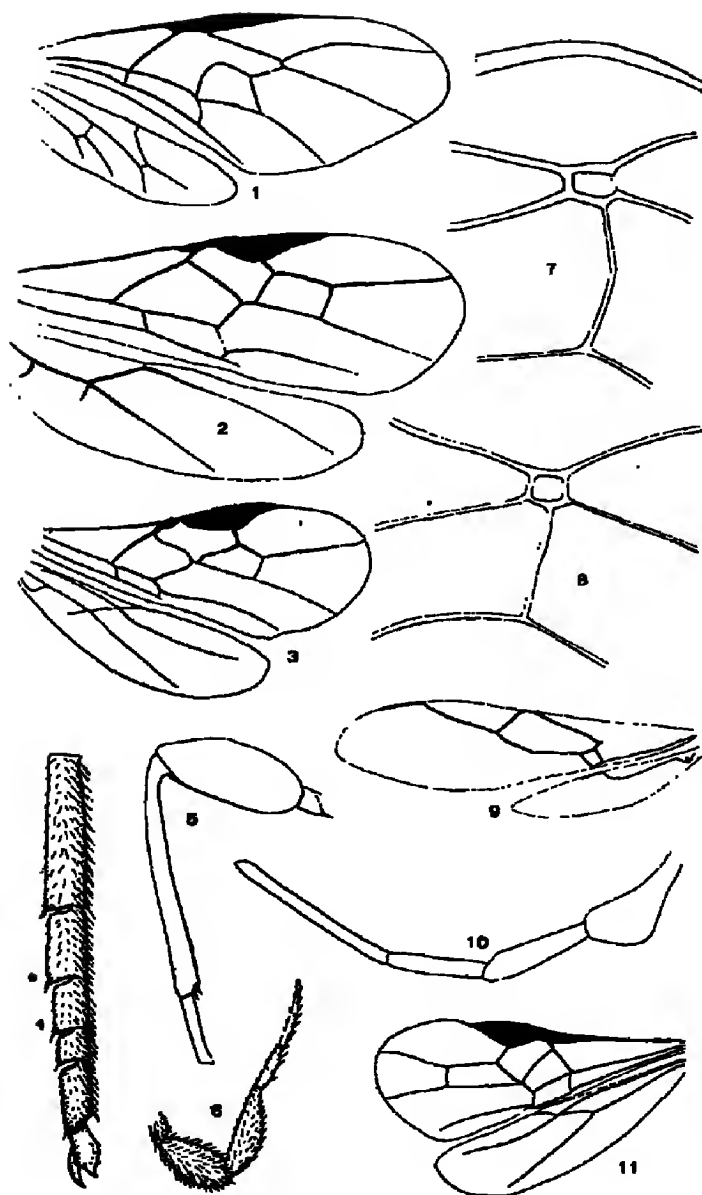
piceous with black stigma and veins. Stigma lanceolate, the radius arising at its posterior third; half as broad as the radial cell; second section of radius twice as long as the first. First section of cubitus sinuate, the recurrent nervure received distinctly before the tip of the first cubital cell; submedian cell considerably longer than the median; subdiscoidal nervure arising below the middle of the discoidal vein, although in position it lies far forward, due to the upper section of the discoidal vein being nearly parallel to the axis of the wing. Hind wing with the radius and subdiscoidal vein well developed.

Four specimens, showing practically no variation, from Abuná, Rio Madeira, Brazil.

This is the first species of *Idiasta* to be described from the neotropical region.

#### EXPLANATION OF PLATE.

- Fig. 1. *Ophiogastrella maculithorax* sp. nov., wings.
- Fig. 2. *Eucystomastax bicolor* gen. et sp. nov., wings.
- Fig. 3. *Idiasta nigripennis* sp. nov., wings.
- Fig. 4. *Bracon crassilarsis* sp. nov., fore tarsus.
- Fig. 5. *Parabinaea manni* gen. et sp. nov., hind leg.
- Fig. 6. *Eucystomastax bicolor* gen. et sp. nov., maxillary palpus.
- Fig. 7. *Mesostenoidens crassus* sp. nov., portion of fore wing.
- Fig. 8. *Cryptus heathi* sp. nov., portion of fore wing.
- Fig. 9. *Ophionellus manni* sp. nov., wings.
- Fig. 10. *Megaplectes branneri* sp. nov., maxillary palpus.
- Fig. 11. *Bracon paraisis* sp. nov., wings.





## THE LACINIA IN THE MAXILLA OF THE HYMENOPTERA.\*

By ALEX. D. MACGILLIVRAY,  
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The maxilla of biting insects consists of six pieces. There is at the proximal end a two segmented cardo (*c*), which articulates the maxilla to the head capsule (Figs. 1 and 2†). Attached to the distal end of the cardo there is in the cockroach (Fig. 1) a rhomboidal-shaped piece, the stipes (*s*). The stipes in the locust (Fig. 2) is also rhomboidal in outline but is limited in its articulation to the mesal portion of the cardo. There is borne at the distal end of the stipes in the cockroach a two-segmented, somewhat bent tongue-shaped piece, the galea, (*g*). The galea of the locust is also two-segmented but borne at the distal and lateral margin of the stipes. At the proximal end of the galea against the lateral margin of the stipes, there is a small sclerite, the palpifer (*p*), which bears the five segmented maxillary palpus. The proximal segment of the galea and the palpifer in the locust constitute the lateral margin of the stipes. There is borne at the distal end of the stipes on the mesal side another appendage, which bears three prominent teeth at its distal end. This is the lacinia (*la*). The arrangement of the parts in the maxillæ of biting insects is for all practical purposes identical with the above description and the figures of the maxillæ of the cockroach and the locust, showing two distal pieces, a lacinia on the mesal side and a galea on the lateral side, with a segmented maxillary palpus attached on or near the lateral margin at the proximal end of the galea, and is characteristic.

If the maxilla of *Macroxyela infuscata* (Fig. 3), one of the most generalized members of the order Hymenoptera, a tenthredinid, known to me, is compared with that of the cockroach

\*Contribution from the Entomological Laboratories of the University of Illinois, No. 29.

†The cardo of *Melanoplus differentialis* as here figured shows a narrow proximal piece with two projections at its proximal end; the shorter piece articulates against the ectal surface of the head capsule and the larger piece passes beneath the margin of the head capsule and serves for the attachment of muscles. These pieces are characteristic of this and some other species. It has been overlooked because it usually remains attached to the head capsule when the maxilla is removed.

or locust, a somewhat similar condition is found. The cardo, however, consists of a single piece which bears at its distal end an irregular-shaped stipes. The stipes bears at its distal end on the mesal side a quadrangular-shaped sclerite, which from its position must be the lacinia. There is borne on the lateral part of the distal portion of the stipes a two-lobed piece, the galea, which consists of a larger outer and a smaller inner lobe. The suture dividing the galea into two pieces is obsolete. Although not demonstrable, it is quite likely that the small mesal lobe of the galea is derived from the proximal sclerite of the galea and the large lateral lobe from the distal sclerite of the galea. The palpifer and maxillary palpus occupy corresponding positions to these sclerites in the cockroach. The maxilla of *Macroxyela* is short and broad and retains many of the general features and appearances of the maxillæ of the cockroach and locust.

The maxilla of *Dolerus unicolor* (Fig. 4), another tenthredinid, differs from that of *Macroxyela* in that it shows some of the tendencies so characteristic of the maxillæ of the higher Hymenoptera, an elongation and narrowing of the parts. This is especially marked in the cardo of *Dolerus*. The maxilla of *Dolerus* also has three lobes at the distal end. The rounded setaceous lateral portion is the homologue of the large lateral lobe of the galea of *Macroxyela*, while the mesal and proximal rounded lobe is the homologue of the small mesal lobe of the galea of *Macroxyela*. The lacinia is a long, pointed lobe projecting beyond the mesal lobe of the galea but attached to the stipes beneath this lobe of the galea. *Dolerus* is a comparatively generalized tenthredinid yet it shows an early stage in the migration of the lacinia from the distal end of the maxilla. A somewhat similar condition is shown in the maxilla of an ichneumonid, *Ophion bilineatum* (Fig. 5). The two lobes of the galea are large, the mesal lobe is a broad flat plate and almost completely covers the lacinia, which is a broad lobe attached to the side of the stipes. The lateral lobe of the galea is elongated and terminal as in the higher Hymenoptera.

In the white faced hornet, *Vespa maculata* (Fig. 6), the maxilla shows a decided elongation of all the parts, the cardo, stipes, and lateral lobe of the galea. The sclerites are not all arranged in the same plane as with the maxillæ previously described. This is due to the fact that the maxillæ are closely appressed to the sides of the convex labium or lower lip, which

changed somewhat the orientation of the parts. The galea is almost as long as the elongated stipes and is composed for the most part of a large lobe which is the homologue of the lateral lobe of the galea of the maxillæ previously described. The homologue of the mesal lobe is much smaller and has changed its position somewhat. It is a small lobe placed on the surface of the larger, lateral lobe, nearer its lateral than its mesal margin. The mesal margin of the small, mesal lobe is marked by a row of long setæ. All the sutures between the parts of the galea and the stipes are obsolete. There are several dark and light areas with oblique ridges where they probably fuse, but specimens prepared with caustic potash show no indication of a suture in this region. The lacinia is a small but well marked lobe attached to the mesal margin of the proximal end of the stipes. Its position is clearly indicated in figure 6. The distal end of the lacinia is usually folded under the proximal end of the galea and more or less concealed. It shows distinctly on unmounted specimens studied in alcohol.

A thread-waisted wasp, *Sphex pennsylvanicus* (Fig. 7), shows a somewhat different condition. In the maxilla of this insect the small, mesal lobe of the galea is wanting and the lateral lobe developed into a greatly elongated, blunt piece, which projects for some distance beyond the stipes and is almost as long as the maxillary palpus. There is a groove along the lateral margin of the galea that may mark the line of separation of the small, mesal lobe of the galea. Unfortunately it was not discovered until it was too late to remedy the defect, that the figure of this maxilla was turned in the opposite direction from the others. The lacinia is located at the proximal end of the galea in this maxilla. It is a broadly rounded lobe. Its location and the development of the proximal end of the galea as an overhanging projection would suggest that the lacinia had been modified into a supporting piece.

The greatest modification of the maxillæ is found with the bees where they have been greatly elongated into plates for close appression against the labium for the formation of a tube. The maxilla of a bumble bee, *Bombus terricola* (Fig. 8), shows this condition well. The galea is a sword-shaped blade as long as the remainder of the maxilla. It is attached to the distal end of the stipes. The two are fused without any indication of a suture. There is an oblique ridge marking the edge of a deep

furrow with lighter intervening parts. It is likely that this oblique, clear area distad of the ridge marks the distal limit of the stipes. This would make the union between the stipes and galea an oblique one with the maxillary palpus attached to the distal prolongation of the stipes. A similar condition will be noted in the other maxillæ figured. The furrow extending across the maxilla is the limit of the distal part of the maxilla that is folded under the labium. If this ridge be considered as the suture between the stipes and the galea, it would place the maxillary palpus on the galea, which is an impossible interpretation in the light of the other maxillæ studied. In the more specialized Hymenoptera, wasps and bees, there is a cuticular membrane connecting the maxilla and the labium, which serves to close the mouth cavity on the ventral side. The distal edge of this membrane is attached to the stipes near the proximal end of the lacinia. This membrane is particularly well marked in mounts of the entire maxilla and labium of *Bombus*. In such mounts, the lacinia can be identified as a round lobe with long setæ on its distal and lateral margins. It is placed adjacent to the distal margin of the membrane extending from the maxilla to the labium and is attached to the mesal margin of the stipes near its distal end or to the uncolored area of the stipes. This lobe is so distinct, once it has been seen, it is hard to understand how it has remained undescribed for so long. The lacinia, while showing distinctly in specimens mounted in balsam, can be studied to better advantage on maxillæ that have been cleared in caustic potash and examined in a watch glass in alcohol.

Insect morphologists have been fairly uniform in their statements regarding the lacinia in the honey bee, *Apis mellifica* (Fig. 9). All the more important text-books on entomology figure a maxilla of *Bombus* or *Apis*, but without indication of the lacinia. The following quotations are typical for the maxilla of *Apis*. Comstock and Kellogg\* describe these parts as follows:

"*Stipes*. The stipes is an irregular, elongate sclerite, strongly chitinized. Its proximal end is bluntly rounded and swollen. The stipes articulates with the proximal segment of the galea (see below) by a diagonal face.

\*Comstock, John Henry and Kellogg, Vernon L. The elements of insect anatomy. Ithaca. 1901. Pp. 78-79.

**Galea.** The *galea* (we incline to believe this part homologous with the galea of the locust's maxilla, rather than with the lacinia, because of its two-segmented condition) extends distad from the stipes as a tapering blade-shaped piece. It is composed of two segments. The proximal one is small and triangular, articulating by the entire length of one of its margins with the stipes. The distal segment or sclerite constitutes the real blade-like portion of the maxilla, and nearly equals in length the ligula and labial palpi (see below). Its surface is unequally divided into two portions by a submedian, dark-brown, longitudinal line. (This line may indicate a coalescence of galea and lacinia into this one blade-like compound sclerite). This line bears several hairs, and there are scattering hairs elsewhere on the sclerite, especially toward the distal end."

Snodgrass† writes as follows of the maxilla of the honey-bee:

"Let us now return to a study of figure 15D. The series of lateral pieces as already explained are the maxillæ. A comparison with figure 3B representing a generalized maxilla will show that these organs in the bee have suffered a greater modification than has the labium, but the parts can yet be quite easily made out. The main basal plate (*st*) is the combined stipes,\* subgalea, and palpifer, the basal stalk is the *cardo* (*cd*), and the little peg-like process (*mx plp*) at the outer end of the stipes is the greatly reduced maxillary palpus. Hence, we have left only the terminal blade-like lobe (*mx*) to account for, and it is evident it must be either the galea or the lacinia (See fig. 3B, *ga* and *lc*) or these two lobes combined. Here again a comparative knowledge of the mouth parts of Hymenoptera comes to our aid and shows clearly that the part in question is the outer lobe or galea, for the inner one becomes smaller and smaller in the higher members of the order and finally disappears."

There is expressed in these two quotations very different views, the former that the galea and lacinia are probably coalesced and the latter that the lacinia is wanting. This is the status of the lacinia in the higher Hymenoptera, writers consider it either as fused with the galea or as obsolete.

A comparison of the drawing of the maxilla of the honey bee with that of *Bombus* shows it to be similar in form but shorter and consists of a long, slender, proximal piece, the *cardo*,

†Snodgrass, R. E.—The anatomy of the honey bee. U. S. Dept. Agr., Bur. Entom., Tech. Ser. No. 18. 1910. Pp. 45-46.



and a distal piece divided into two regions by the difference in coloration. The distal two-thirds is a blade-shaped piece with a median ridge bearing setæ. This blade-shaped piece is the galea and the median ridge is the supposed line of coalescence of the galea and lacinia of Comstock and Kellogg. There is borne on the lateral margin at the proximal end of the galea a two-segmented appendage, the palpifer and a one-segmented maxillary palpus. The palpifer is inserted in a furrow on the side of the maxilla and can be pushed back against the bottom of this furrow so as not to project beyond the lateral margin of the maxilla. There is a distinct convexity at the distal end of this furrow and an oblique line extends across the maxilla from this point, which probably marks the division between the galea and the proximal piece of this portion of the maxilla, the stipes. The suture between the galea and stipes is obsolete. The lacinia is a thin, cuticular lobe attached near the mesal margin of the stipes at its distal end. It is not attached at the margin of the stipes but a short distance within. The lacinia at its distal margin is developed into a lobe which rests upon the base of the galea. It is so delicate that where it rests upon the galea, its distal end appears like a faint, curved, transverse suture. The distal end of the lacinia resting upon the galea is evidently what Comstock and Kellogg have mistaken for a suture separating the galea into a triangular proximal piece and a distal blade-like piece. The lacinia is larger and more distinct in the honey bee than in *Bombus*. It shows very distinctly on specimens cleared in caustic potash and studied in alcohol.

The lacinia was found to be present in the maxillæ of practically all the Hymenoptera examined. It is very large and distinct in *Priocnemis*, fully one-third the size of the galea which is greatly expanded and consists of two distal lobes. In the large carpenter ant, *Campanotus*, the lacinia is a distinct lobe at the proximal end of the galea. Wheeler\* considers it as present but his figures of the maxillæ copied from Janet do not show it. A species of *Andrena* also shows it as a lobe similar in form and location to that of *Bombus* and *Apis* but smaller. The only hymenopterous insect examined where the lacinia was found to be completely wanting was the short tongued bee,

\*Wheeler, W. M.—Ants, their structure, development, and behavior. New York. 1910. P. 19.

*Microchlora*. In this bee the galea has been reduced to a mere oblique knob at the distal end of the maxilla and the stipes transformed into a blade-shaped organ with a distinct palpifer and a five segmented maxillary palpus on the lateral margin near the distal end of the maxilla.

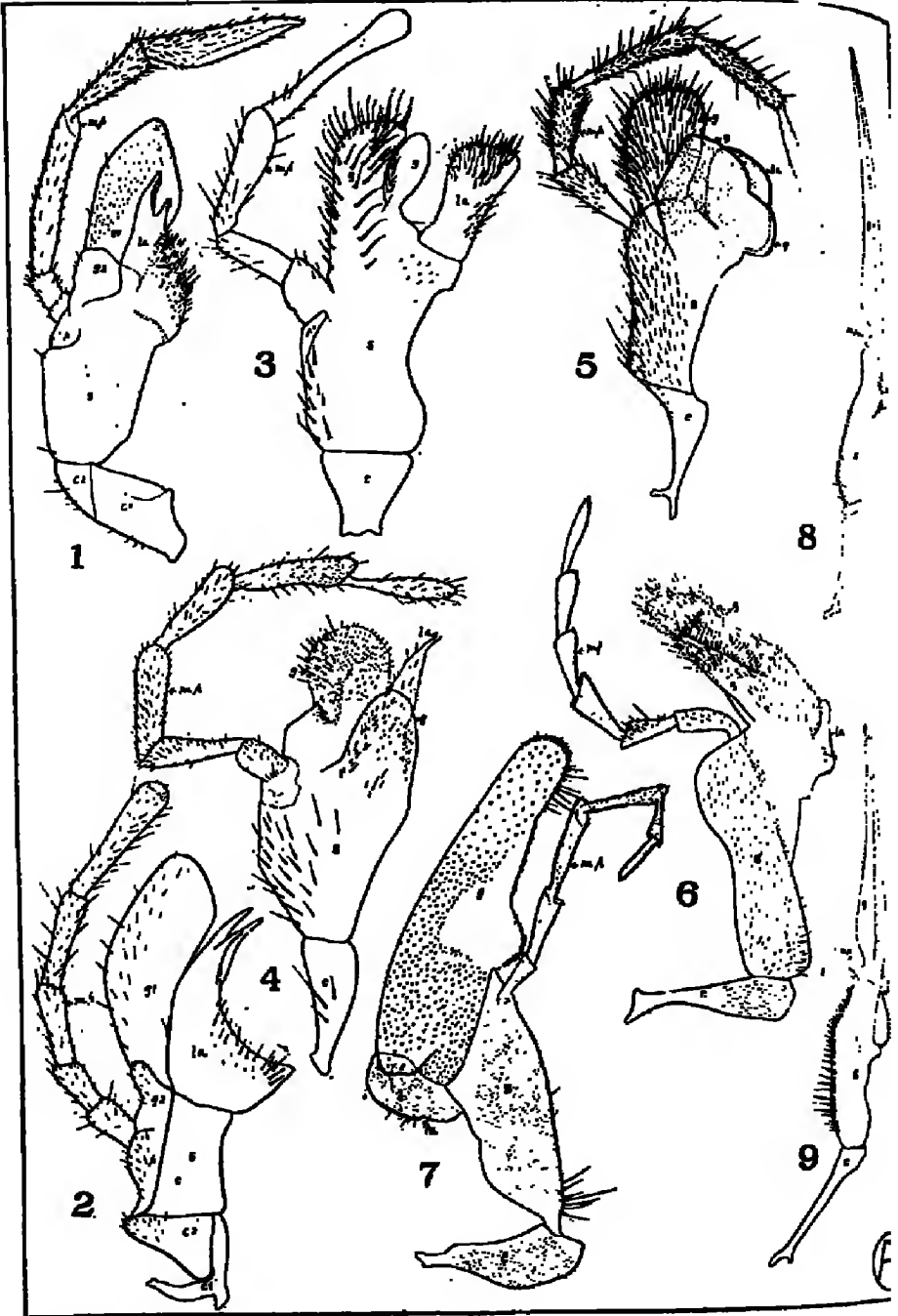
## LIST OF ABBREVIATIONS.

- c. Cardo.
- c1. Proximal segment of cardo.
- c2. Distal segment of cardo.
- g. Galea.
- g1. Distal segment of galea.
- g2. Proximal segment of galea.
- la. Lacinia.
- mp. Maxillary palpus.
- p. Palpifer.
- s. Stipes.

## PLATE XVIII.

(Drawings by Alvah Peterson.)

1. *Periplaneta orientalis*.
2. *Melanophus differentialis*.
3. *Macroxyela infuscata*.
4. *Dolerus unicolor*.
5. *Ophion bilineatum*.
6. *Vespa maculata*.
7. *Sphex pennsylvanicus*.
8. *Bombus terricola*.
9. *Apis mellifica*.



A. D. MacGillivray.

## THE PUPAL WINGS OF *HEPIALUS THULE*.

By ALEX. D. MACGILLIVRAY,

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The adult wings of the different species of the genus *Hepialus* are of particular interest because they show such a generalized condition. They approximate the closest to the hypothetical wing type of Comstock and Needham of any insect's wings with which I am acquainted. This hypothetical type is supposed to show the number and arrangement of the longitudinal veins as they existed in the primitive insect's wing. These authors have shown that a study of the arrangement of the tracheæ preceding the formation of the veins in developing wings throws much light on the homology of the veins of the adult wing. Many developing wings of Lepidoptera have been studied and figured, but so far as I am aware no investigator has studied and figured the developing wing veins of a species of *Hepialus*. It was my good fortune, through the kindness of Professor J. M. Swaine of MacDonald College, Quebec, Canada, to obtain pupæ of *Hepialus thule* hardened in formol in the right stage for a study of the developing wing veins. These specimens showed not only the tracheæ, which are represented as black lines on the accompanying figure, but also the veins, which are represented as white bands. Unfortunately nothing could be determined as to the arrangement of the tracheæ after they left the veins and entered the body. The various veins will be taken up in order.

**Costa.**—The costa can be traced as a distinct, unbranched vein in both wings a short distance within the costal margin. A trachea was found only in the costa of the front wings and this was only a mere stub.

**Subcosta.**—The subcosta shows as a two-branched vein, identical in form with the subcosta of the hypothetical type. The tracheal stem of subcosta is distinct and in the front wing branched midway between the base of the wing and the point of separation of subcosta into  $Sc_1$  and  $Sc_2$ , though in the hind wings the point of branching of the trachea is much nearer the point of separation of the two branches of subcosta. The

\*Contribution from the Entomological Laboratories of the University of Illinois, No. 30.

tracheal branch supplying  $Sc_1$  is much weaker than that extending through  $Sc_2$ . The preservation of both branches of subcosta is peculiar to the Jugatae among the Lepidoptera. In the Hepialidae, this condition differs with the different species; in some species they are both well preserved, in others the portion representing the free part of  $Sc_1$  is sometimes present in both wings, sometimes present in the front wing and wanting in the hind wing or *vice versa*, or it may be entirely wanting in both wings, while in still other species no trace of it is ever found. The portion of subcosta always preserved is the long, straight stem representing  $Sc_2$ , so that if we may judge from the form of the vein preserved and the decadent condition of the trachea of  $Sc_1$ , as shown here, the tip of the subcosta as preserved throughout the higher Lepidoptera must be  $Sc_2$ .

*Humeral Cross-Vein.*—The humeral cross-vein is usually preserved in the Hepialidae. It is distinct in this species and located in its usual place between costa and subcosta near the base of the wing.

*Radius.*—The radius, both so far as the tracheae and the developing veins are concerned, consists of five branches. A basal stem dividing dichotomously into an unbranched vein,  $R_1$ , and a stem which divides dichotomously into  $R_2+$ , and  $R_4+$ . Each of these in turn divide dichotomously, the anterior into  $R_2$  and  $R_3$  and the posterior into  $R_4$  and  $R_5$ . The number of branches and their method of dividing is identical with the hypothetical type. The radius of the hind wings of *Hepialus* as is common in the Jugatae, contains as many branches as the radius of the front wings.

*Media.*—The media of both wings is similar in form and consists of three branches. The median trachea of each wing lies in the same vein cavity as the radial trachea at the proximal end of the wing. They extend along side by side for some distance, then the medial trachea bends away from the radial trachea, and pass into the median vein cavity. The median tracheae branch dichotomously near the base of each wing, the anterior branch from this dichotomy after a short distance divides again dichotomously into  $M_1$  and  $M_2$ . The posterior branch from the first dichotomy passes unbranched directly to the wing margin. This branch of media in the hypothetical type gives rise to  $M_3$  and  $M_4$ . None of the pupal wings of *Hepialus* examined gave indication of smaller

branches arising from this trachea. The cross-veins are all without tracheæ as is the usual condition in generalized wings. The posterior branch arising at the first dichotomy of media in *Hepialus* is undoubtedly the homologue of the posterior branch at the first dichotomy of media of the hypothetical type. This branch in the hypothetical type divides dichotomously

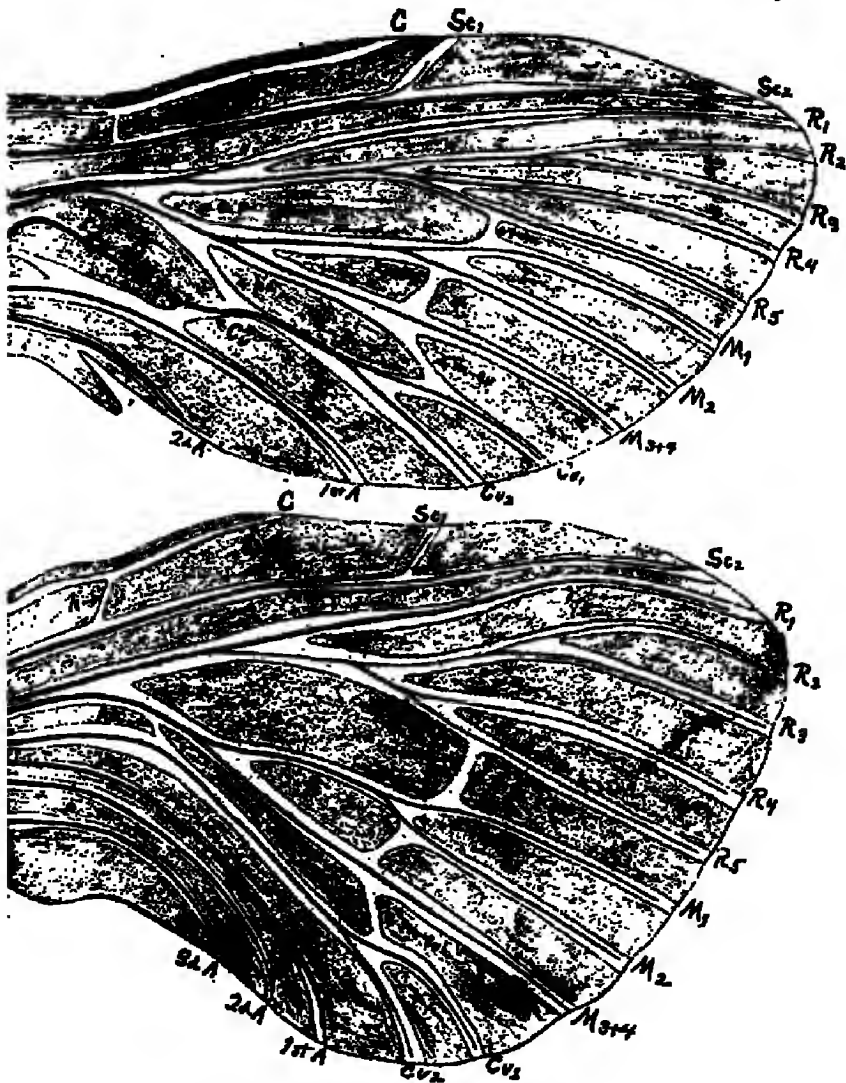


Fig. 1. *Hepialus thule*, pupal wings.

into  $M_3$  and  $M_4$ , so that this branch in *Hepialus* must represent  $M_3$  and  $M_4$  or as it is here labelled,  $M_3+4$ . The position of the branch  $M_4$  in the Lepidoptera has not been definitely placed. Comstock and Needham figure the wings of *Sthenopsis*, in the hind wing of which there is an extra branch on  $Cu_1$ , which they label as  $M_4$ . This would mean, if this interpretation is correct, that  $M_4$  is coalesced with  $Cu_1$  in the higher Lepidoptera. The wings figured are of a species in which  $Cu_1$  is usually unbranched. The specimen figured is undoubtedly an abnormal specimen so far as the branching of  $Cu_1$  is concerned and should have no weight in deciding what has become of  $M_4$ . That the above authors were in doubt is shown by the following foot-note taken from their paper: "With our present knowledge it is impossible to determine the way that vein  $M_4$  has disappeared in the Frenatæ. We have seen no indication that it coalesces with vein  $Cu_1$  as in *Sthenopsis*, for in all pupæ of this suborder that we have examined the medial trachea is only three-branched. We are obliged, therefore, to omit any further reference to this vein in the discussion of this order." The venation of certain species of *Hepialus* is frequently abnormal. This is strikingly true of *Hepialus humuli*. I have seen wings which had extra branches on both media and radius. In the case of radius, specimens have been examined that contained six, seven, and even eight branches. So that the condition figured in the hind wing of *Sthenopsis* is not unusual. The fact that none of the pupal wings showed any branching of this portion of the trachea of media in either wing and the further fact that *Hepialus* is one of the most generalized of lepidopterous insects, where of all places positive evidence should be sought for demonstrating this point, the interpretation must be, that the third branch of media in both wings, not only of *Hepialus* but of the Lepidoptera, is  $M_3+4$ .

**Radio-Medial Cross-Vein.**—The radio-medial cross-vein is distinct, in its usual place between  $R_3$  and  $M_1$ , and is not preceded by a trachea.

**Medial Cross-Vein.**—The medial cross-vein is present, distinct, in its usual position between  $M_2$  and  $M_3$ , and is not preceded by a trachea.

**Cubitus.**—The vein cavity of the cubitus of the front wing is located some distance behind the radio-medial vein cavity. It is free for a short distance at the base of the wing, then it

with another vein to a point opposite the point of separation of media and radius. Here the cubitus bends abruptly toward the apex of the wing for a short distance and then turns abruptly again toward the wing margin, parallel with  $M_4$ . Just before reaching the wing margin, it divides into  $Cu_1$  and  $Cu_2$ . The basal part of the cubital trachea of all the front wings studied did not lie in the cubital vein but took a short cut toward the base of the wing. With the limited material at hand it is impossible to determine whether this is a normal condition or an artifact due to the mounting. The cubital vein cavity and trachea of the hind wing is situated much nearer to the medial trachea and vein cavity than in the front wing. The cubitus extends parallel to the media until near the wing margin where it divides into two branches,  $Cu_1$  and  $Cu_2$ .

**Medio-Cubital Cross-Vein.**—The medio-cubital cross-vein is present, distinct, and in its usual position between  $M_3+4$  and  $Cu_1$ . This cross-vein differs from the other cross-veins in its oblique direction, a direction very suggestive that this was the course of the fourth branch of media. The entire lack of tracheæ in these veins defeats such an interpretation.

**Arculus.**—The arculus is a cross-vein-like structure at the base of the wing extending between radius and cubitus. The term arculus was first used for this structure in the wings of the Odonata, but as pointed out by Comstock and Needham, it is present in the wings of many insects. It is well developed in the wings of many Diptera but has not been pointed out hitherto in the wings of the Lepidoptera. The arculus, while cross-vein-like, is in reality a compound structure. The stem of media passes to the base of the wing midway between radius and cubitus to the arculus, makes an abrupt bend to the front of the wing, forming the anterior portion of the arculus, extends to radius, and then makes another abrupt bend and extends to the base of the wing in combination with radius. The posterior part of the arculus is a true cross-vein, extending from the first abrupt bend of media to the cubitus. The anterior or median portion of the arculus may be designated as the anterior arculus (*aa*) and the posterior part, consisting of a cross-vein as the posterior arculus (*pa*).

Both front and hind wings of *Hepialus thule* show a well developed arculus. Practically all of the carefully prepared drawings of the wings of the Jugatæ give some hints as to the



actual condition, though most of them indicate the media as coalesced at base with cubitus. An examination of the pupal wings of *Hepialus thule* shows the tracheæ of the media lying along side the tracheæ of radius in the wing cavity of radius. A short distance from the base of the wing the median trachea diverges from the radial trachea into a broad vein cavity of its own, which passes obliquely across the wing for a short distance and then turns toward the margin of the wing between and parallel to the radial and cubital vein cavities and tracheæ. The oblique part of the median vein cavity is the anterior arculus (*aa*). Near the point where the median trachea bifurcates, a broad vein cavity joins the median vein cavity and passes obliquely, posteriorly to the cubitus. This latter oblique vein cavity is not supplied with a trachea. It is the cross-vein part of the arculus, the posterior arculus (*pa*). The posterior arculus of the front wing is much longer than that of the hind wing. This explains why in adult wings, the media frequently appears to be joined to the radius in the front wing and to the cubitus in the hind wing.

There is a great variation in the constituent parts of the arculus in the wings of different insects. This is especially true in the Diptera. A generalized condition is found in many wings, such as those of *Tabanus* or *Leptis* where the median vein joins the middle of the arculus. In such cases, the anterior arculus and the posterior arculus are subequal in length. Two lines of modification may be developed from this generalized condition. The media may migrate along the arculus nearer and nearer to the radius until it actually joins the radius. The anterior arculus through this migration becomes shorter and shorter, with a corresponding lengthening of the posterior arculus. When the media joins the radius, the anterior arculus is obliterated and the arculus is wholly cross-vein in structure or posterior arculus. If the posterior arculus atrophies in the descendants of such forms, the radius would appear to arise directly from the radius without an abrupt bend. The second condition is found where the media migrates toward cubitus. There results a similar shortening of the posterior arculus and an elongation of the anterior arculus. This may proceed until the media is free from the arculus and coalesced with the cubitus as in the wings of *Pantorbes* or *Erax*. Whereas the cross-vein like structure was all cross-vein or posterior arculus in the first

in the second case it is all median or anterior arculus. A partial atrophy of the anterior arculus may take place and a condition like that found in the wings of the muscids occurs, where media appears to arise from cubitus. This shows that even in the two wings of the same species, as certain *Jugatae*, the media may appear to arise from the radius in the front wings and from the cubitus in the hind wings.

*Anal Veins.*—The front wings of *Hepialus thule* has two anal veins, each represented by a trachea. The first anal vein is coalesced for a part of its course with the stem of cubitus. Many figures of wings of *Hepialus* show a cross-vein between cubitus and the first anal vein, the cross-vein is the true course of cubitus. The apparent continuation of cubitus proximad of this cross-vein is the posterior arculus. The second anal vein lies close to the wing margin and the vein cavity is not well developed. The hind wing has three well developed anal tracheæ in three equidistant vein cavities. The vein cavity of the first anal vein is not so distinct as the others.

## ANATOMY OF THE TOMATO-WORM LARVA *PROTOPARCE CAROLINA*.\*

By ALVAR PETERSON.

The larvæ of *Protoparce carolina* are excellent subjects for the study of the anatomy of a developing insect. Its size and abundance during the late summer and early fall make it an available subject throughout the middle west. There are no detailed investigations of the larva of this family, so that a discussion, such as is given in the following pages, would not seem out of place. This investigation was started under Dr. A. D. MacGillivray, in order to acquire some information as to the internal anatomy of insects. Since there is such a dearth of literature dealing with the larvæ of American Lepidoptera, I have prepared, at his suggestion, the following descriptions and figures. I am greatly indebted to Dr. MacGillivray for suggestions and other help. I have found Mr. A. G. Hammer's excellent paper on the nervous system of the larva of *Corydalis cornuta* L. very useful and wish to express my appreciation of it.

### METHODS.

When the work was first taken up, it was doubtful if it could be completed in one season, for only a limited amount of good material was available. There still remain a few points that need further observation, and these will be mentioned later. The best material for dissection proved to be larvæ that had been killed in hot water and preserved in 70% alcohol. Even with the largest and the best prepared specimens, one finds that the internal structures are not as easy to follow as one might expect. Especially is this true with respect to the nervous and circulatory systems. The factor causing the greatest difficulty outside of the frailty of the material, is the existence of a superabundance of adipose tissue or fat. To remove this fat, without tearing or destroying other parts, in order to observe the various organs, is difficult. The larvæ were opened by cutting a longitudinal slit along the meson on the dorsal or ventral aspects and laid out flat and pinned in dissecting trays. By gently rubbing and teasing the masses of adipose tissue, one can remove a sufficient amount to be able to observe the covered

\*Contribution from the Entomological Laboratories of the University of Illinois, No. 31.

Staining the tissues with a weak solution of Delafield's fast blue No. 1 was found very useful in differentiating the finer structures. This was especially true in working with the nervous and circulatory systems. The resulting light-bluish stain given to the tissues, when not stained too deeply, proved to give the best results. Stained material will retain the stain for three or four days without becoming muddy and indistinct. To stain a certain area, the obstructing material was cleaned away and rinsed clean with running water. Pouring off all the water, two or three drops of the stain were dropped on the moist parts. The stain in no case was allowed to remain on the tissues over thirty seconds. As a general rule, the surplus stain was immediately washed off with running water.

The various parts of the larva will be discussed in the following order:—

A. External Anatomy:—Head, Thorax, and Abdomen.

B. Internal Anatomy:—Adipose Tissue, Digestive System, Milk Glands, Salivary Glands, Respiratory System, Muscular System, Circulatory System, Reproductive Organs, Wing Buds, and Nervous System.

#### A. External Anatomy.

The larva of *Protoparce carolina* when mature is approximately 9 cm. in length and 12–15 mm. in diameter. It has a distinct greenish cast with diagonal lines of dark brown, pigmental blotches, which extend from the dorso-caudal part of each abdominal segment ventro-cephalad. The body is divided into three regions, head, thorax, and abdomen.

HEAD (Figs. 1, 2 and 3).—The head is the smallest division of the body. It is a non-wrinkled, yellowish-white region, which from a lateral or ventral aspect is oval in outline, while from a cephalic view, it is spherical. On the median portion of the cephalic aspect, there exists a distinct inverted Y-shaped suture (*e*), the epicranial suture, which divides the fixed parts of the head into three regions. Connected with the ventral part of the region included within the arms of the Y, are the mouth parts. The large areas laterad of the epicranial suture have on their ventral aspects the antennæ and simple-eyes.

Eyes.—The simple eyes (*o*) consist of two groups of six ocelli, five of which are arranged in a semicircle with the sixth on the median part of the diameter of the circle. These groups

viewed from the cephalic aspect, are on the ventro-lateral regions of the head.

*Antennæ*.—Mesad and slightly ventrad of the ocelli are located the three-segmented antennæ (*at*). Each consists of a conical-shaped basal segment bearing on its distal end two similar, cylindrical segments. On the distal end of the third segment, two unequal setæ are borne, the mesal one being the longer.

*Front*.—The triangular area included within the arms of the Y, is the front (*f*).

*Clypeus*.—The clypeus (*cl*) is attached to the ventral edge of the front and forms a transverse bar, bearing a single seta on each lateral end.

*Labrum*.—At the apex of the clypeus, there is borne a bilobed area (*lr*), which has on its ventral edge a deep notch, which makes the labrum bilobed. On the lateral and ventral parts of these lobes are borne setæ. Three large setæ for each lobe seems to be the constant number in the various specimens examined, while there is a variation in the number of small setæ on the depressed region above the notch.

*Mandibles*.—The two stout mandibles (*md*) meet in a zigzag line caudad of the labrum. The zigzag line is due to the interlocking of the four dark, tooth-like projections which occur on the mesal edge of the laterally opening mandibles. The mandibles are connected to the head proper at the lateral margins of the labrum and maxillæ. Each mandible bears on its distal median portion a single seta.

*Maxillæ*.—Directly caudad of the proximal portion of the mandibles are two globular maxillæ (*mx*), each of which bears ventrally a three-segmented, tapering palpus. The distal segment of the palpus is very small.

*Labium*.—Mesad of the two maxillæ, there is a wedge-shaped labium (*lb*), which gives rise to a tubular projection at its caudo-distal edge.

*Spinneret*.—This tubular projection (*s*), which extends caudad and ventrad, is the spinneret, from which the silk is exuded.

**THORAX**.—The thorax, being the second region of the body, is adjacent to the head and consists of three segments as follows:

*Prothorax* (Fig. 1).—The prothorax is the cephalic segment of the thorax and is comparatively smooth and not transversely

marked on its dorsal aspect. It bears on its ventral side a pair of true legs. On the caudal part of the lateral surface of the prothorax can be seen an oval spiracle.

*Mesothorax and Metathorax* (Fig. 1).—The mesothorax and metathorax are very similar, consequently the description of either will answer for both. Six, transverse furrows cut the dorsal surface of each segment and a pair of true legs is found on the ventral aspect of each. These two segments bear no spiracles.

*Legs* (Figs. 11g and 5).—The three pairs of legs on the thorax are approximately alike. On all these legs numerous small setae are borne. A leg consists of the following parts. At the base of each leg is a widened, oval, furrowed area, which constitutes the coxa (*co*) of the leg. The trochanter (*tr*), a wedge-shaped, darkened sclerite, exists on the ventro-mesal margin of the coxa adjacent to the following segment of the leg, the femur. The femur (*fe*) is the large, cylindrical segment distad of the trochanter. The tibia (*ti*) follows the femur and bends slightly mesad. The distal segment of the leg is a small, cone-shaped tarsus (*ta*), which bears on its distal end, minus an intervening suture, a single, dark-hooked claw (*ca*).

*ABDOMEN* (Fig. 1).—The abdomen is by far the largest portion of the larva, for it consists of eight, possibly nine, large segments. Some writers consider the eighth segment, as it is here called, as made up of two segments. The proleg (*a. pl*) of the last segment in this case would be attached to the ninth, while the anal horn (*ah*) would be borne on the caudo-dorsal part of the eighth segment. In the abdominal segments one to seven, a distinct similarity exists. However the abdominal segments three, four, five and six, give rise to pairs of prolegs (*pl*).

*Fourth Abdominal Segment* (Fig. 1).—Taking the fourth abdominal segment as a typical segment, one finds it is composed of eight, distinct, transverse, ridges on its dorsal and dorso-lateral aspects. Numerous pigmental areas can be found in the furrows. The most striking pigmental arrangement is the diagonal line of spots running from the dorso-caudal angle of the segment toward the ventro-cephalic portion. The large, oval spiracles (*s*) are located on the lateral aspects of the segments in the ventral and cephalic portion. These oval, darkened areas (Fig. 6, *s*) on magnification appear to be made up of a fine network of dark chitin and also show an indefinite,

median, dorso-ventral slit, which opens into the trachea. The prolegs (*pl*) on the ventral aspect of this segment, are a pair of fleshy appendages, which bear on their distal margins a convex, double row of black hooks, which point mesad (Fig. 4).

*Eighth Abdominal Segment* (Fig. 1).—The last segment of the abdomen is somewhat elongated and not so excessively cut by transverse furrows as the preceding segments of the abdomen. At the middle of the dorsal surface of the segment, a spine-like anal horn (*ah*) arises. From this point the segment is cut off obliquely at an angle of  $45^{\circ}$ . At the dorsal edge of this sloping portion the triangular anal plate (*ap*) is located. The anus (*a*) is situated ventrad of the anal plate. The anal prolegs (*a. pl*) resemble in most details the prolegs of the fourth abdominal segment. However their size is a trifle larger and the relation of their connection with the ventral surface of the segment is somewhat different. The spiracle (*s*) of this segment may be seen in its usual position.

## B. Internal Anatomy.

### ADIPOSE TISSUE.

On opening a larva, the first thing noted is the abundance of fat, or adipose tissue (Fig. 10). Adipose tissue, as seen throughout the body, is the white, flocculent, lobulated, ribbon-like material surrounding and adjacent to the various organs in the body cavity. This fat tissue is stored up for future metamorphosis. Sections and mounts of adipose tissue stained with eosin show (Fig. 10) its oily nature. The large spherical, fat cells in their crowded, massed condition assume a polygonal form. Internally, the cells are filled with oily globules of fat and possess also a dark-staining, centrally located nucleus. To rid the larva of this fat, one needs carefully to rub and tease it loose.

### ALIMENTARY CANAL.

Extending from the mouth to the anal opening of the larva, there is a long, straight, locally constricted tube, which in the abdominal region occupies the greater portion of the body cavity. This is the alimentary canal, or digestive tract. On opening a larva from the dorsal aspect (Fig. 7), the following structures may be observed:—

*Pharynx* (Figs. 7, 8, and 18).—The pharynx (*p*) is the smallest part of the digestive tract and is located at the extreme

tic end within the head. It proceeds from the ventrally-dorsad, mouth opening, dorsad and caudad till it enlarges into a region called the oesophagus. The more or less distinct flexure in the pharynx occurs for the most part caudad of the head ganglia. The abruptness of this flexure depends in great part upon the position of the head. The pharynx as represented in the figures has been straightened. Arising from the pharynx are bundles of muscles that attach themselves to the head capsule.

*Oesophagus*.—As the pharynx begins to widen caudad of the flexure within the head, the oesophagus (*oe*) here begins and extends caudad to the ventriculus (*ve*), which is in the cephalic region of the metathorax. This trumpet-shaped piece has a finely, transversely striated ectal surface.

*Ventriculus*.—The ventriculus (*ve*), is a long, straight, large, transversely folded tube, which extends from the caudal end of the oesophagus to the caudal portion of the sixth abdominal segment. The transverse, folded, outer covering of the ventriculus is divided into six areas by means of six fine, longitudinal bands of muscles, which extend the full length of the ventriculus. The six bands have the following positions. One band is dorsal along the meson, one ventral along the meson, two dorso-lateral, and two ventro-lateral.

*Gastric Cæca*.—Located at the dorso-cephalic end of the ventriculus, between the terminations of the muscle bands, there are four groups of small, white, rounded bodies (*ce*), the gastric cæca.

*Small Intestine*.—Caudad of the smooth, slightly converging, caudal end of the ventriculus, there is a distinct constriction, which is immediately followed by a small ring-shaped area, the small intestine (*s. i.*). On the ectal surface of the small intestine, pits exist through which tracheæ and muscles fibres enter. From the ventral aspect, two small bladders may be seen, which enter the small intestine at its latero-cephalic portions.

*Large Intestine*.—The smallest constriction in the caudal region of the alimentary tract, which is just caudad of the small intestine, is the beginning of the large intestine (*l. i.*). Immediately following this middle constriction there is a flaring shoulder, which again becomes constricted caudad, but not to as great an extent as the constriction just described. Two more small, shoulder-like areas follow this constriction, the



anterior one being very slight. This constitutes the large intestine. The above shape and form holds true only when the intestine is completely empty and relaxed. Excreta within will cause the large intestine and rectum, which follows, to assume various shapes.

*Suspensory Muscle of the Large Intestine.*—These two muscles (*s. m.*) extend from the ventral side of the cephalic margin of the caudal enlargement of the large intestine to the latero-ventral portion of the transverse conjunctiva, between the sixth and seventh abdominal segments. These two cord-like muscles can be best seen from the ventral aspect.

*Rectum.*—The rectum (*re*) is the caudal termination of the alimentary canal and occupies the caudal portion of the seventh abdominal segment and the entire portion of the eighth. The rectum is the largest in diameter of all the portions of the alimentary canal. On the dorsal surface of the rectum, there are located two prominent, longitudinal bands of muscles that converge at the cephalic end of the rectum and connect at their caudal end to the body wall. By means of the contraction of the rectum, the characteristic form is given to the excreta of lepidopterous larva.

*Tracheæ of the Alimentary Canal.* (Fig. 7, *t*).—The tracheæ of the oesophagus and pharynx are very small and their arrangement is difficult to trace. From the adjacent first six abdominal spiracles there is a fan-like arrangement of tracheal branches which enter the lateral, folded area of the ventriculus. These tracheæ support the ventriculus and supply it profusely with air. Tracheæ from the seventh abdominal segment lead to the large and small intestine and the cephalic area of the rectum. However, the rectum obtains most of its oxygen by means of the tracheæ coming from the eighth abdominal segment.

#### URINARY SYSTEM.

The urinary system (Figs. 7 and 9) of *Protoparce carolina* is composed of two bladders, right and left, and their respective tubules. Fig. 9 shows a bladder (*b*) and how it enters the anterior part of the small intestine on the ventro-lateral portion. It has been pulled out of its normal position in order to show the place of attachment of the bladder with the small intestine. It turns back on itself, as in Fig. 7, and thus conceals its place of entrance. Leading cephalad from the small, delicate, white

After, there is a common duct, which splits immediately and gives rise to two branches; one continues cephalad on the ventral side (*v. m. l.*), while the other passes dorsad and divides into two branches (*d. m. l.*), both of which proceed cephalad along the dorso-lateral part of the ventriculus. Tracing a ventral Malpighian tubule, we find that it extends cephalad in a nearly straight line, adjacent to the ventro-lateral portion of the ventriculus to the second abdominal segment. At this point it turns abruptly back and continues caudad and parallel with itself until it reaches approximately the seventh abdominal segment, where it becomes very convoluted and soon loses itself in the mass of convoluted, terminal, Malpighian tubules and adipose tissue. The pairs of dorsal tubules proceed cephalad and parallel into the second and third abdominal segments. The mesal tubule of the pair within the third abdominal segment, turns mesad and caudad, while the lateral tubule turns laterad and caudad within the second abdominal segment. After turning, both tubules proceed caudad and parallel with their cephalad-extending portion until they reach the sixth abdominal segment, where they turn laterad and continue into the seventh abdominal segment soon to become highly convoluted and intertwined with the ventral, terminal tubules and adipose tissue. The tubules are easily detected not only from their position, but from their form. They appear like long, white, knotted strings. The proximal portion of a tubule is more or less flattened and consists of scattered, white, globular nodules. As a tubule proceeds distad, the nodules become more frequent until finally at the terminal part of a tubule, as it enters the seventh abdominal segment, the tubule consists of a series of closely packed, irregularly arranged nodules. It was impossible to determine the termination of a tubule on account of the intertwining of the tubules, their delicate consistence, and the ever present adipose tissue.

#### SILK GLANDS.

Running along each side of the lateral portions of the ventriculus (Fig. 7, *sg*) and imbedded in the adipose tissue of the lateral body wall, are two opaque, smooth, yellowish-white cords. These two cords are the silk glands. They extend from the base of the spinneret on the labium into the seventh abdominal segment. The right and left silk glands of this larva

are practically of the same size throughout their length. However, the cephalic end from the metathoracic region to the point of attachment to the spinneret is much smaller and serves probably only as a conducting tube. These conducting tubes can be traced into the head until they reach the chitinous projections on the caudal margin of the head, around which they bend at right angles and unite on the meson. Farther than this the duct was not traced. As one traces, caudad from the metathoracic region, a silk gland proper, one sees the beginning of the coiled or rather convoluted portion of this organ. Within the fifth and sixth abdominal segments the convolutions are most abundant. The gland terminates in the mass of Malpighian tubules and adipose tissue within the seventh abdominal segment.

#### SALIVARY GLANDS.

The two salivary glands (Fig. 7, *sl*) appear as delicate, white, nodulated, twisted tubes on each side of the pharynx and oesophagus. They extend from the anterior portion of the head to the region of the metathorax and here end within a flattened mass of adipose tissue on the ventral wall of the thorax marking the line of division between the mesothorax and the metathorax. Tracing a gland into the head, it follows along the space between the muscles and the lateral margin of the pharynx to the margin of the tendon of the adductor muscle of the mandible, where it becomes much reduced in size.

#### RESPIRATORY SYSTEM.

In the discussion of external anatomy, it was noted that there were nine spiracles, eight of which were abdominal and one thoracic. Opening a larva from the ventral side and removing the alimentary canal and a part of the adipose tissue, a system of more or less transparent, white, smooth tubes, similar to Fig. 11, reveals itself. To follow the tracheæ with most satisfactory results, one should open a freshly killed larva and immerse the same in water. In this case the tubes would be filled with air and appear as glistening, silver cords.

Arising from each spiracle, there is an immense, bush-like mass of tracheæ, that branch into many fine tubes, which in most cases extend to the various parts, such as muscles, nerves, alimentary canal, legs, heart, etc., of the same body segment. This holds true of the abdominal segments only. All the

Spiracles of each side open into the main, longitudinal trachea which extends between the spiracles and is amply long to allow for expansion of the body segments. A unique fact, to note in regard to these connecting tracheæ, is that each gives rise to several lateral branches varying from two to six or more in number.

In examining specimens for transverse tracheal connections between spiracles of the same segment, none were found on the dorsal aspect except from the thoracic spiracle and the eighth abdominal spiracle. If other dorsal cross tracheæ exist, they must be very minute and delicate, for they were carefully sought. In the case of the eighth abdominal segment, only one minute dorsal cross trachea was found (Fig. 11), while in the prothoracic region, two distinct, cross tracheæ were observed, the cephalic one being the larger and giving rise to two pairs of tracheæ, which proceed cephalad and ventrad into the anterior portion of the head. The caudal cross trachea of the two gives rise to four or five minute pairs of tracheæ, which diverge in various directions. It should be mentioned, that the tracheal system varied considerably in minor details in different specimens. Looking on the ventral aspect for cross tracheæ, it was found that a small cross trachea existed near each ganglion of the nervous system (Fig. 13) except the supra-oesophageal ganglion, which is located dorsad and cephalad of the pharynx. The cross tracheæ adjacent to the metathoracic and mesothoracic ganglia seemed to originate from branches of the connecting tracheæ between the first and second spiracles of the body. In all cases, with one exception, the cross tracheæ lie ventrad of the nerve cord and in the abdominal region caudad of the ganglia. The one exception is the cross trachea that lies adjacent to the suboesophageal ganglion. In this case the trachea is dorsad of the commissure (II. 2g.). Each cross trachea on the ventral aspect gives rise to a pair of tracheæ that supplies the adjacent ganglion.

#### MUSCULAR SYSTEM.

In the gross treatment of the muscular system (Fig. 12) of this larva only the more prominent bands of muscles will be mentioned. The muscular system of the larva is segmentally arranged. The muscle fibres are confined in their extent to a single segment and furthermore the muscular arrangement is similar in each segment on the whole. This is especially true

with the abdominal segments. Consequently the description of a single segment will answer as a type of all the segments. The muscles of the thorax are more complex, due to the muscles of the legs.

*Great Dorso-Recti Muscles (g. d-r.m.).* The broad area of white, opaque muscles lying to the right and left of the heart are the great dorso-recti muscles. Upon a superficial examination of the ends of the muscles at the conjunctiva, one might be led to think that the muscles were continuous, except for a slight depression. But as a matter of fact, they are contiguous and separated by a narrow, hyaline, cuticular line at the point of the depression. These particular muscles attach themselves to the cephalic side of the transverse conjunctiva.

*Small Dorso-Recti Muscles (s. d-r. m.).*—Laterad of the lateral margin of the great dorso-recti muscles, the small dorso-recti muscles are located. This band of muscles consists of three to five small fibres that are fastened to the caudal margin of the transverse conjunctiva. Laterad of this bundle of muscles an area exists, which is free of longitudinal muscles but contains the spiracles and their accompanying tracheæ.

*Great Ventro-Recti Muscles (g. v-r. m.).* If the larva is spread out as in Fig. 12, the large band of muscles laterad of the free area consists of the great ventro-recti muscles. This group is ventrad of the spiracles. These muscles attach themselves to the cephalic aspect of the transverse conjunctiva.

*Small Ventro-Recti Muscles (s. v-r. m.).*—These muscles are located mesad of the great ventro-recti muscles along the ventral area of the larva adjacent to the nervous system. They are attached to the caudal side of the transverse conjunctiva. All these muscles are supplied by tracheæ.

*Dorso-Ventral Muscles (d. v. m.).*—The dorso-ventral muscles are the two groups of short muscles that extend dorso-ventrad across the free area existing between the great ventro-recti muscles and the small dorso-recti muscles, one group at the cephalic end of the segment and the other at the caudal end. Two fibres, the cephalic group, cross immediately cephalad of the spiracle and mesad of the longitudinal trachea between the abdominal spiracles and mesad of the small dorso-recti muscles. The other remaining fibres disappear dorsally in the cephalic part of the segment as the two already described fibres but ventrally they cross at an angle the transverse conjunctiva

and disappear from view in the extreme caudal part of the preceding abdominal segment. Other muscles besides those thus far discussed are present in each body segment. By carefully lifting the longitudinal fibres, one finds other bands of muscles running at an angle to those named above. This is indicated in Fig. 12, (x), where in the caudo-dorsal angle of the front part about the spiracles in each segment one sees the ends of such diagonal bands.

#### CIRCULATORY SYSTEM.

Dorsad of the alimentary canal is a long slender tube (Fig. 12) embedded to some depth in a mesal cavity of adipose tissue between the right and left bands of the great dorso-recti muscles. This tube, which comprises the whole of the enclosed circulatory system, extends from the eighth abdominal segment to and within the head. The enlarged part of this tube, extending from the eighth abdominal segment into the meta-thoracic region, is the pulsating organ, the heart.

*Heart.*—The heart (*h*) is a very delicate, flattened, muscular tube closed at the caudal end and presumably opening in each segment by a system of valves. Owing to the lack of fresh and living material the valves of the heart were not studied. After injecting some colored fluid into fresh specimens, the valves should readily show themselves.

*Wings of the Heart.*—Within the area of the first to the fifth abdominal segments, four pairs of laterally extending fan-like rays of tendons (*w. h.*) are seen. The tendons extend from the ventro-lateral edges of the heart and converge at the point where the three anterior dorso-ventral muscles penetrate between the great dorso-recti muscles and the small dorso-recti muscles. The wings are composed of connective tissue and muscle fibres, connecting themselves to the body wall beneath the small dorso-recti muscles. The function of the wings of the heart is probably to protect the heart from the peristaltic movements of the alimentary canal. Between successive fans the heart proper is distinctly constricted. In these regions without much doubt the valves of the heart are located. The caudal part of the heart, extending from the midportion of the fifth abdominal segment to the caudal end, is supported by scattered, irregularly arranged tendons on the ventral surface, that attach themselves to the nearby body wall.

*Aorta*.—The cephalic extension of the heart, the aorta (Fig. 8), starting within the metathoracic region and passing into the head, is a much smaller and smoother muscular tube. It runs close to the dorsal surface of the oesophagus and the pharynx and finally terminates with a slight dilation after it has passed beneath the supra-oesophageal ganglion (Fig. 8 and 18). The location of the outlet allows a constant and abundant supply of fresh blood within the head region. The mouth-like opening of the aorta is held in its characteristic position by means of tendons that connect themselves to the head capsule (Fig. 8).

The heart, like the other organs of the body, is well supplied with air tubes. The arrangement of the heart-tracheæ is shown in the fifth abdominal segment (Fig. 12).

#### REPRODUCTIVE ORGANS.

After examining numerous specimens for gonads, two white, opaque, ovate bodies (Fig. 12, *r*) were found on each side adjacent to the heart in the fifth abdominal segment. Difficulty was experienced in locating these organs on account of their close similarity to adipose tissue and their being embedded in the same. It was impossible to determine the sex of the glands on account of the limited material at hand. From the fifth abdominal spiracle, tracheæ arise that supply the reproductive organs.

#### WING BUDS.

The wing buds (*f. b.* and *h. b.*) are the histoblasts, imaginal discs, or imaginal buds of the future wings of the adult insect. They are formed as invaginations of the hypodermis, to which they are attached. They are small, kidney-shaped bodies located in the dorso-lateral portions of the mesothorax and metathorax. If a larva is cut along the ventral meson, the wing buds will be seen about midway between the meson and the outer cut body wall. Two tracheæ enter the wing buds at their base, one into the caudal portion and the other into the cephalic portion.

#### NERVOUS SYSTEM.

The nervous system (Fig. 13) of *Protoparce carolina* consists of a long, white cord, knotted at segmental intervals, which extends for the most part along the meso-ventral portion of the body. This ventrally located, simple nervous system is made up of three parts: ganglia, commissures, and nerves. The

enlarged, oval knots, found in each segment of the body, are the ganglia. Only one ganglion exists in each body segment outside of the head and the seventh and eighth abdominal segments. The cords running between the ganglia, which in some cases are double or partially so, are the commissures. The nerves are the branches of various sizes extending from each ganglion and in some cases from the commissures. These fine threads permeate all parts of the body. The nervous system will be discussed under the following divisions: Abdominal Ganglia, Thoracic Ganglia, Head Ganglia, and Sympathetic Systems of the Head.

**ABDOMINAL GANGLIA** (Fig. 14 and 15).—The abdominal ganglia are the simplest in type. The distinct similarity between the first six abdominal ganglia makes it possible for one description to answer for all. The seventh and eighth abdominal ganglia will be discussed under a separate heading.

**First Six Abdominal Ganglia** (Fig. 15, *A. 1g*).—The first six abdominal ganglia are located in the middle or cephalic part of each abdominal segment and consist of the following parts:—

**Lateral Nerves.**—The lateral nerves (*l*) are the two branches, which arise from the cephalic part of the lateral margins of the ganglia and innervate the latero-dorsal portion of the body.

**Ventral Nerves.**—Directly caudad and slightly ventrad of the lateral nerves, the ventral nerves (*v*) arise and extend caudo-laterad to innervate the ventral area of the body segments. Near the point of entrance of the ventral nerves, a pair of small nerve-like tracheæ enter the ganglia. These two tracheæ, one on each side, are derived from the transverse tracheæ located in each abdominal segment ventrad of the nerve cord. The tracheæ can be distinguished from the nerves by staining with Delafield's hematoxylin as heretofore advocated. A stained trachea is more deeply colored than a nerve and also shows its distinct ringed nature on high magnification.

**Ventral Sympathetic System** (Fig. 15, *m.* and *t. n.*).—Extending between the ganglia there is a single, large, white cord, the commissure. Just before the commissure enters the cephalic end of a ganglion, it divides into two cords or is furrowed on the dorsal surface. The ventral sympathetic nerves arise from the cephalic end of this fork. With some of the ganglia, this forking or splitting of the commissure is not very great but can in each case be detected.



*Median and Transverse Nerves.*—The median nerve arises from the commissure at the cephalic end of this inverted V-shaped split and extends caudad for a short distance. At its caudal end near the ganglion, it forks and gives rise to two transverse nerves (*t. n.*), that extend in opposite lateral directions and more or less parallel with the lateral nerves. In the short distance in which the transverse and lateral nerves are parallel, the transverse nerves give rise to a web of nerve fibres (*px*), which connect with the lateral nerves and the ganglion. Beyond this web or plexus, the transverse nerves diverge from the lateral nerves in a cephalo-lateral direction.

*Ganglia Seventh Abdominal Segment.* (Fig. 14, A. 7 and 8 g).—Within the seventh abdominal segment, is a double ganglion, or rather two ganglia, but no visible commissure connects the two because of the close approximation of the ganglia. This modification brings about a change in the nerves.

*Seventh Abdominal Ganglion.*—The seventh abdominal ganglion is comparable to the ganglia of the first six abdominal segments. It gives rise to nerves arranged in the same manner and does not need further description.

*Eighth Abdominal Ganglion.*—The elimination of the commissure between the seventh and eighth ganglia has not only brought the ganglia together but has lengthened as well as changed the place of origin of the nerves from the ganglion.

*Lateral Nerves.*—The comparatively large lateral nerves (*l*) arise not from the lateral margin of the ganglion but from its dorso-caudal end and extend with a slight divergence far into the eighth abdominal segment before branching.

*Ventral Nerves.*—Ventrad and slightly laterad of the lateral nerves, there arises a small pair of ventral nerves (*v*), which also extend into the eighth abdominal segment before branching. Adjacent to these ventral nerves the accompanying tracheæ, which resemble nerves closely enter the ganglion. The ventral trachea of the eighth abdominal segment, however, still exists in its normal position within the eighth segment. This elongates to a great extent the pair of tracheæ that arise from it to supply the eighth abdominal ganglion.

*Ventral Sympathetic System* (Fig. 14, *m.* and *t. n.*).—The fusing of the seventh and eighth abdominal ganglia causes the sympathetic system apparently to arise from the dorso-caudal end of the seventh abdominal ganglion.

*Median and Transverse Nerves.*—The median nerve (*m*) arises from the mid-dorsal area of the double ganglion. It is very short. On teasing apart the two ganglia, the median nerve remains attached to the caudal end of the seventh abdominal segment. It immediately gives rise to its pair of transverse nerves (*t. n.*), which extend caudo-laterad into the eighth abdominal segment more or less parallel to and laterad of the pair of lateral nerves. However, no plexus exists between the transverse and lateral nerves of this ganglion, as was noted in the other segments.

*THORACIC GANGLIA* (Fig. 17, *T. 1g*, and *T. 2g*, Fig. 16, *T. 3g*).—The thoracic ganglia are three in number, the mesothoracic and metathoracic ganglia are similar in form.

*Mesothoracic and Metathoracic Ganglia* (*T. 2g* and *T. 3g*).—The mesothoracic and metathoracic ganglia are slightly larger than the abdominal ganglia and are not as far apart. Extending from the caudal ends of all the thoracic ganglia, there is a large commissure (Fig. 17) which, in case of the prothoracic and mesothoracic, proceeds but a short distance and then forks and forms the diamond-shaped area in which the ventral sympathetic nerves are located. In both cases, the diamond-shaped area between the metathoracic and mesothoracic and between the mesothoracic and prothoracic ganglia occupies about two-thirds of the distance between the ganglia.

*Lateral Nerves.*—The lateral nerves (*l*) proceed from the ganglia at their latero-cephalic part and are adjacent to the lateral edges of the commissures. The lateral nerves extend in a latero-cephalic direction.

*Connective Nerves.*—The connective nerves (*c. n.*) arise from the lateral edges of the commissure and extend in a caudal direction. In the case of the diamond-shaped area between the mesothoracic and metathoracic ganglia, the connective nerves arise midway between the anterior and posterior angles of the diamond. While, with the diamond-shaped area between the prothoracic and mesothoracic ganglia, the commissure gives rise to its connective nerves very much nearer the mesothoracic ganglion than to the anterior end of the opening. The connective nerves proceed a short distance caudad, then turn laterad and somewhat cephalad, and soon fuse with the lateral nerves laterad of their connection with the commissure. Before fusing with the lateral nerves, the connective nerves give rise